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OCEANOGRAPHIC MEASUREMENTS IN THE CHUKCHI SEA AND BAFFIN BAY - --ETC(U)
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PREPARED FOR:

ARCTIC SUBMARINE LABORATORY, CODE 54
NAVAL OCEAN SYSTEMS CENTER, SAN DIEGO, CALIFORNIA
UNDER CONTRACTS N00123-74-C-2064 AND N00123-77-C-1013

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by G. R. Garrison

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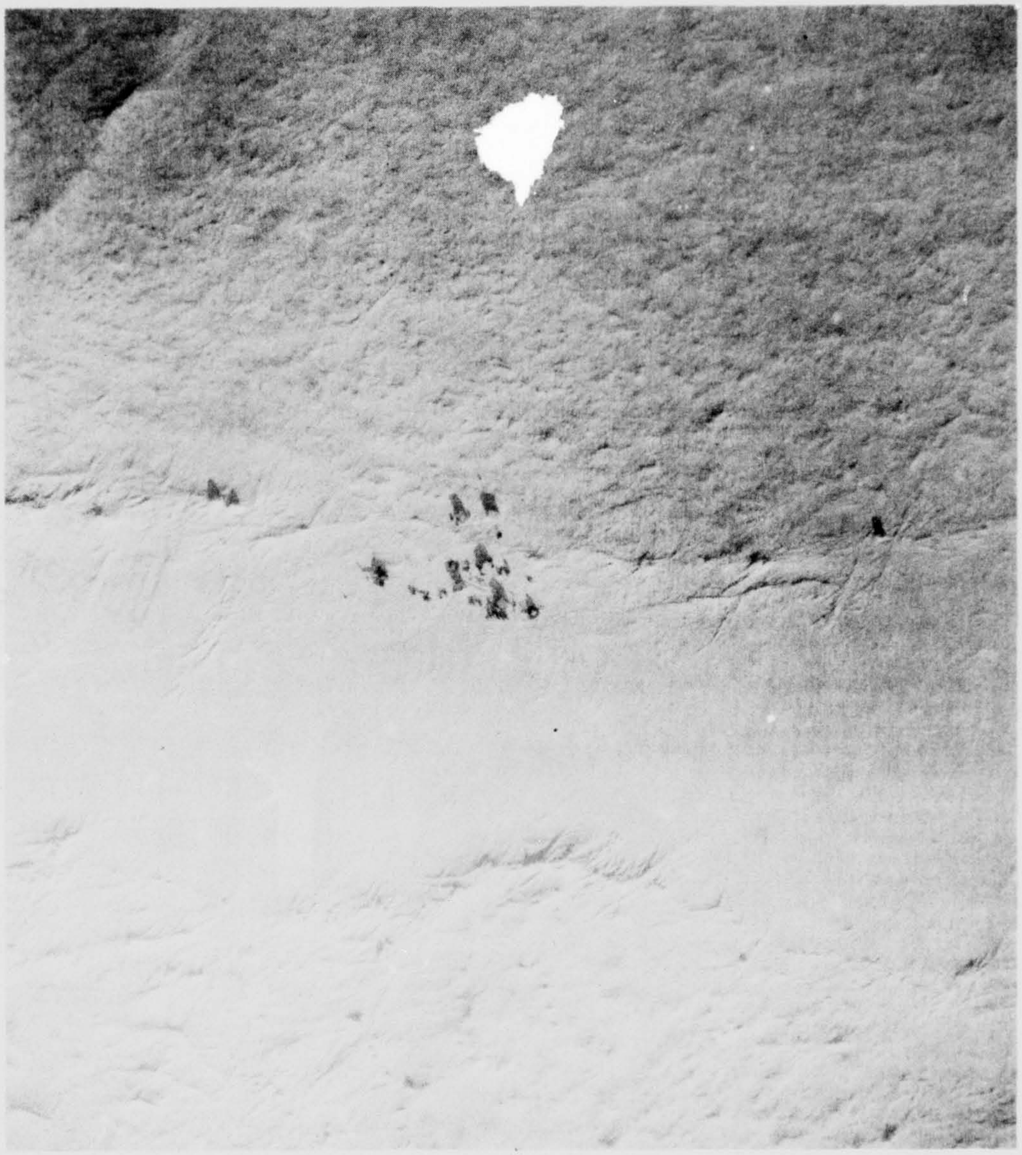

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SUMMARY

Bottom layers of homogeneous water have been found in the Chukchi Sea each year since the MIZ studies began in 1971. In April 1976, a bottom layer of high-salinity, near-freezing water was traced along the coast in the eastern Chukchi Sea and throughout the Barrow Canyon. This layer is believed to have originated in the shallower portions of the Chukchi Sea, where high-salinity water forms in the winter when the surface freezes. The bottom layer appears to have gravitated down the Barrow Canyon until it reached its density level at an accumulation of cold water often observed at a depth of approximately 120 m in the adjoining Arctic Ocean. There is also evidence of an uprising of Atlantic water from depth in the Arctic Ocean into the Barrow Canyon and an extension of the "temperature-maximum" layer of the Arctic Ocean as far southwest as Pt. Franklin. Alternations of these opposing movements appear to coincide with changes in the atmospheric pressure gradient between Barrow and Nome. Also, there is some lateral displacement, with the temperature-maximum layer lying seaward of the descending bottom layer.

INTRODUCTION

The Arctic Submarine Laboratory has sponsored oceanographic studies in the Chukchi Sea yearly since 1971. These surveys have revealed many interesting features of the water exchange and layering that occur in the Barrow Canyon and along the coast from the Bering Strait to Pt. Barrow. The results have been described in reports[1-4] and a paper[5] by APL personnel, and in several reports published by the Naval Postgraduate School.[6-10]

The innovation of the Laboratory's lightweight CTD (conductivity-temperature-depth) profiler[11] in 1975 made oceanographic measurements from light aircraft a practicality. When operated from a helicopter the CTD allows a station to be taken every half hour. As long as there is sufficient daylight and reasonable weather, stations can be taken in any season, through the ice after landing or while hovering over open water.

In 1975, a bottom layer of cold, saline water was found off the mouth of the Barrow Canyon in the neighboring depths of the Arctic Ocean.[4] The 1976 measurements reported here were concentrated near the upper end of Barrow Canyon to trace the extent of the cold, saline layer to the southwest.

Measurements were taken in March at an ice camp north of Wainwright. These measurements were followed in April by lines of stations perpendicular to the coast at several locations from Wainwright to Pt. Barrow, and one line into the Arctic Ocean east of Pt. Barrow. Measurements were taken again in September along three lines of stations radiating from Pt. Barrow to examine conditions in the fall. Thus the 1976 measurements cover nearly the complete annual cycle. This cycle, however, tends to be obscured by year-to-year variations.

An icebreaker cruise through the Davis Strait into Baffin Bay early in the spring presented an opportunity to gather oceanographic data in the marginal ice zone (MIZ) on the Atlantic side.

MEASUREMENTS AT ICE CAMP APLIS, 24 MARCH TO 5 APRIL 1976

Ice camp APLIS (Figure 1), about 80 km north of Wainwright, was established primarily for a series of acoustic experiments which will be described in another report. The data collected during routine measurements of weather, current, temperature, salinity, and floe drift are presented here because of their contribution to the oceanographic description of the area.

Figure 1. Ice Camp APLIS.

Weather

The weather measurements consisted of air temperature, wind velocity, and air pressure, with additional notes on visibility. Table I is a summary of the weather log. The air temperature was read from a mercury thermometer mounted outside the window of a wooden hut. Air pressure

Table I. Weather Summary for Ice Camp APLIS

Month	Day	Local Time	Air Temperature (°F)	Air Temperature (°C)	Air Pressure (uncalibrated) (Hg)	Visibility	Wind Speed (kn)	Wind Direction (deg true)
March	22	0800	-18	-28	---	Hazy	≈15	NE
		1300	-10	-23	---	Good	≈15	NE
	23	0700	-17	-27	---	Good	≈15	NE
	24	0600	-22	-30	29.89	Excellent	≈ 0	SW
		1300	-10	-23	29.87	Excellent	≈ 0	---
		1930	-16	-27	29.82	Excellent	4.5	236
	25	0550	-18	-28	29.78	Excellent	3.5	120
		1900	-12	-24	29.68	Excellent	7.3	---
	26	0800	-19	-28	29.60	Excellent	0	205
		1230	- 8	-22	29.59	Excellent	0	---
		1910	-13	-25	29.64	Excellent	0	107
	27	0530	-19	-28	29.72	Excellent	0	29
		1515	- 6	-21	29.84	Excellent	0	54
		2130	-19	-28	---	Excellent	0	327
	28	0600	-24	-31	---	---	---	---
		1330	- 8	-22	29.94	Excellent	5.0	248
		1900	-14	-26	29.95	Excellent	5.3	229
	29	0600	-17	-27	29.93	Excellent	5.2	197
		1830	-12	-24	29.93*	Excellent	6.2	170
	30	0600	-19	-28	29.94	Excellent	4.4	136
		1250	- 5	-21	29.99	Excellent	3.2	102
	31	0530	-21	-29	30.00	Excellent	4.5	75
		1600	- 2**	-19	29.99	Excellent	8.5	80
		1900	-10	-23	30.00	Excellent	7.0	82
April	1	0600	-20	-29	29.97	Excellent	7.9	69
		1900	-10	-23	29.88	Excellent	10.1	70
	2	0610	-14	-26	29.84	Excellent	9.9	58
		1640	- 2**	-19	29.84	Excellent	10.8	65
	3	0600	-18	-28	29.84	Excellent	6.0	48
		1700	- 6	-21	29.81	Excellent	11.4	44
	4	0615	-12	-24	29.84	Poor	12.0	54
		1355	- 2	-19	29.82	Fair	13.4	47
		1700	- 2	-19	29.83	Poor	12.0	56
	5	0530	- 1	-18	29.88	Fair	7.8	58
		1320	+ 1	-17	29.93	Fair	6.8	60
	6	0630	+ 1	-17	29.99	Fair	5.3	44
	7	0600	-16	-27	---	Excellent	5.0	South

*All readings were adjusted to make this reading agree with the pressure reported for Barrow on the broadcast radio.

**The thermometer was in the direct sunlight for these measurements.

was recorded on a barometer provided by the Naval Arctic Research Laboratory (NARL) at Pt. Barrow. A calibration of the barometer was not available; at one time a pressure report on the radio weather broadcast was used to adjust the readings, but the barometric data should be considered accurate only in a relative sense. The wind velocity was determined by a three-cup anemometer and wind vane mounted on a 7-m high pole with a read-out inside the hut. The true direction of the wind vane reference was obtained from daily readings of the magnetic compass of a surveyor's transit. There was no noticeable rotation of the floe after the transit was set up on 26 March.

Current Measurements

Current measurements were taken by lowering a Marsh-McBirney electromagnetic probe to various depths and reading the surface meters after the reading had stabilized. Polar plots showing the true direction and magnitude of the current are presented in Figure 2. Measurements were taken both on the way down and on the return to the surface.

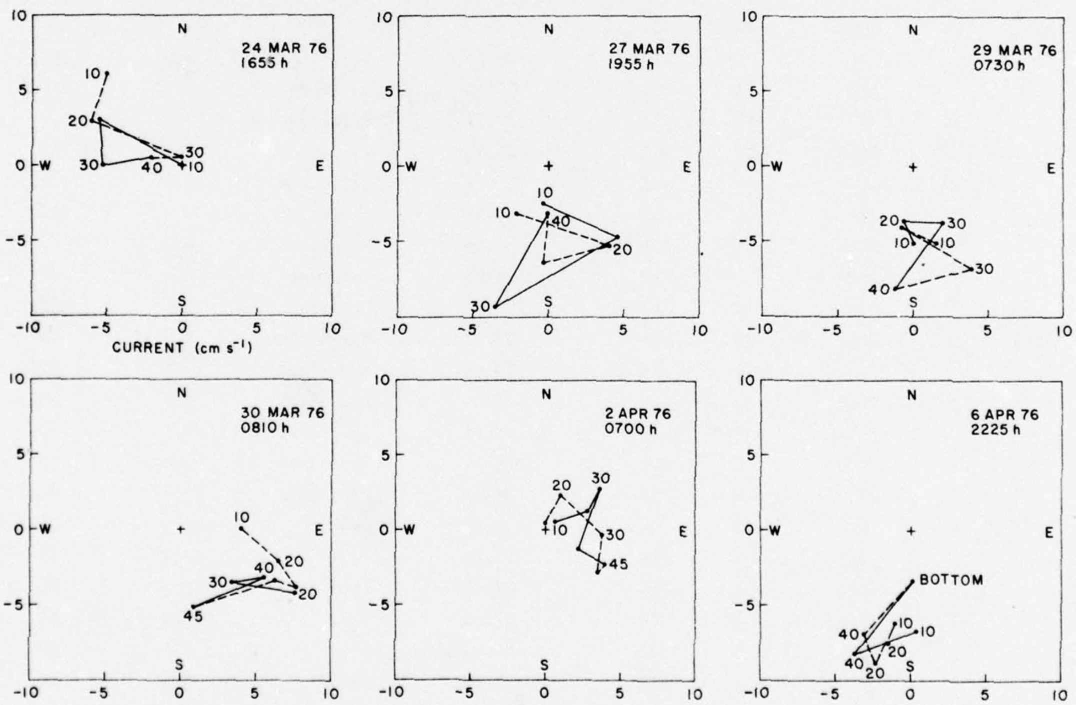

Figure 2. Measurements of relative current beneath the floe. Vectors from the origin to each point represent the velocity of the current relative to the floe at the depth indicated. Dashed lines are meter stops on the way up.

Temperature and Salinity Profiles

The APL lightweight CTD profiler[11] was attached to the inside wall of a hut above a 40-cm diameter hole through the floor and the ice as shown in Figure 3. The probe was lowered and raised by a hand crank. Temperature, conductivity, and depth data were recorded on magnetic tape, which was re-read into a desk calculator/plotter. Approximately two sets of temperature and salinity profiles per day for the period 24 March to 6 April are presented in Appendix A. A comparison of the salinity profiles for this period is shown in Figure 4. At first, the salinity in the upper 30 m increased, but toward the end of the period it decreased. This is thought to result from two processes: (1) As the ice thickens the salinity of the underlying water increases; (2) since this increase is greater in the shallow Chukchi Sea than in the adjacent, deeper Arctic Ocean, convection currents may result, bringing the lower-salinity water in the upper layers westward into the Chukchi Sea.

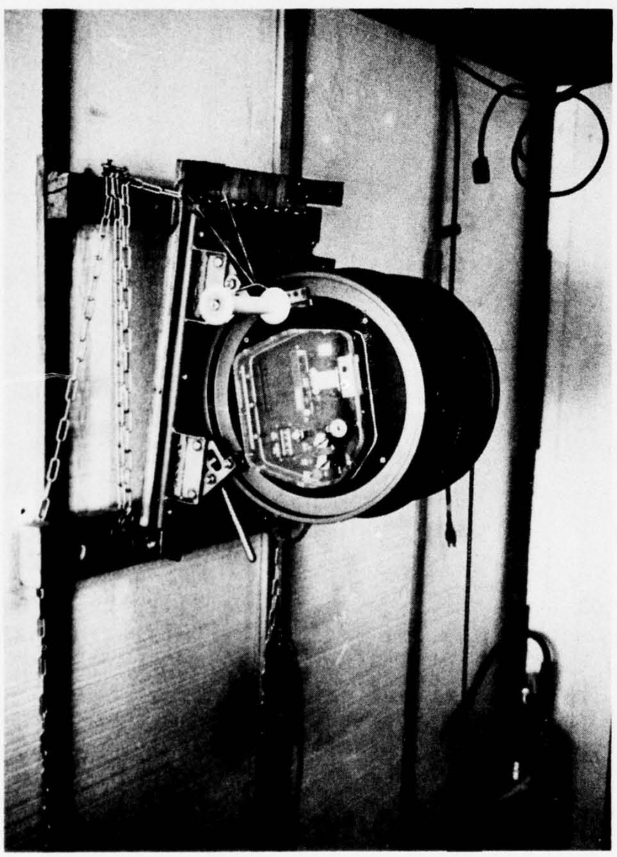

Figure 3.
The lightweight CTD profiler mounted on the wall of the generator hut so that the probe could be dropped directly into a hole through the floor and ice.

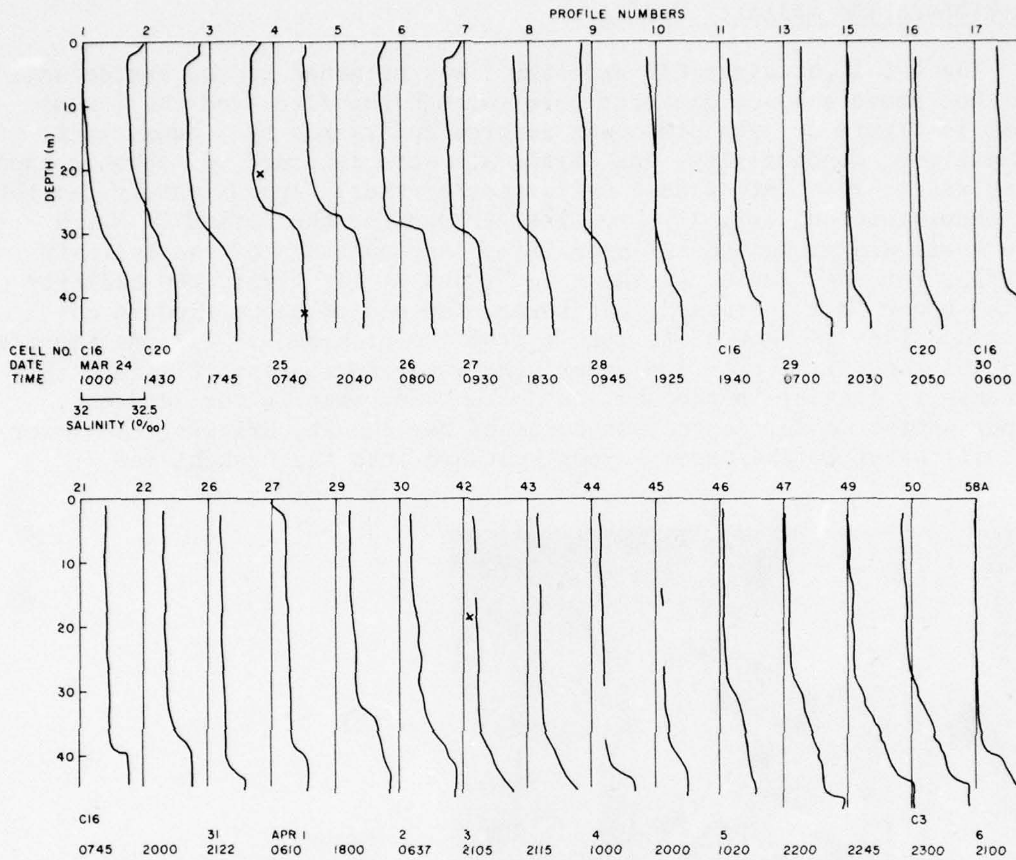

Figure 4. Salinity profiles obtained at Ice Camp APLIS, 24 March to 5 April 1976. Nansen sample checks on the salinity are indicated by x's.

A few Nansen bottle samples were taken to check the salinity values. These were tested later in a conductivity cell at the University of Washington's chemical oceanography laboratory. These checks are indicated on the profiles in Figure 4. The conductivity cell was occasionally changed, as indicated by the C numbers below the profile. Some discrepancies were noted, giving rise to some uncertainty in the accuracy of the salinity profiles. More consistent results were obtained after the cells were cleaned on 26 March.

Ice Floe Drift

Two transmitters were operated at the camp for satellite tracking of the floe. The position data were received after returning from the field trip. Examination of these data indicates a standard deviation of about 2 km. This estimate was obtained by comparing the results of several fixes taken during one day, and by comparing the results from the two transmitters. Since the total displacement during the 16 days was only about 15 km, the details of the movement can not be well established. However, a careful examination of the data indicates that the floe very likely made two oscillations parallel to the coast. This movement is diagrammed in Figure 5, in which each point represents a rough average of all fixes on that particular day.

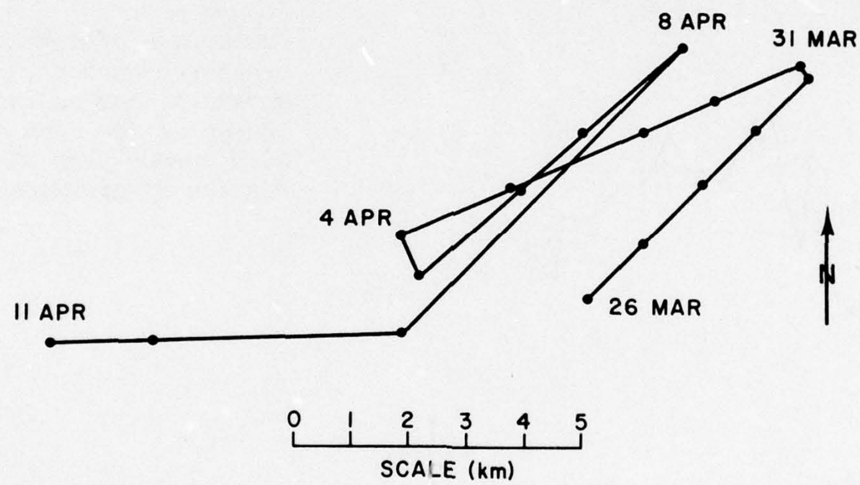

Figure 5. Diagramatic floe movement during the occupancy of Ice Camp APLIS, 1976.

Interrelation of Ice Camp Observations

To investigate the correlation between atmospheric pressure, wind, floe drift, currents, and water properties, these data have been plotted together with the same time reference in Figure 6. The figure contains:

(1) The atmospheric pressure excess at Barrow over that at Nome, as reported by the weather stations.

(2) The atmospheric pressure readings at the ice camp.

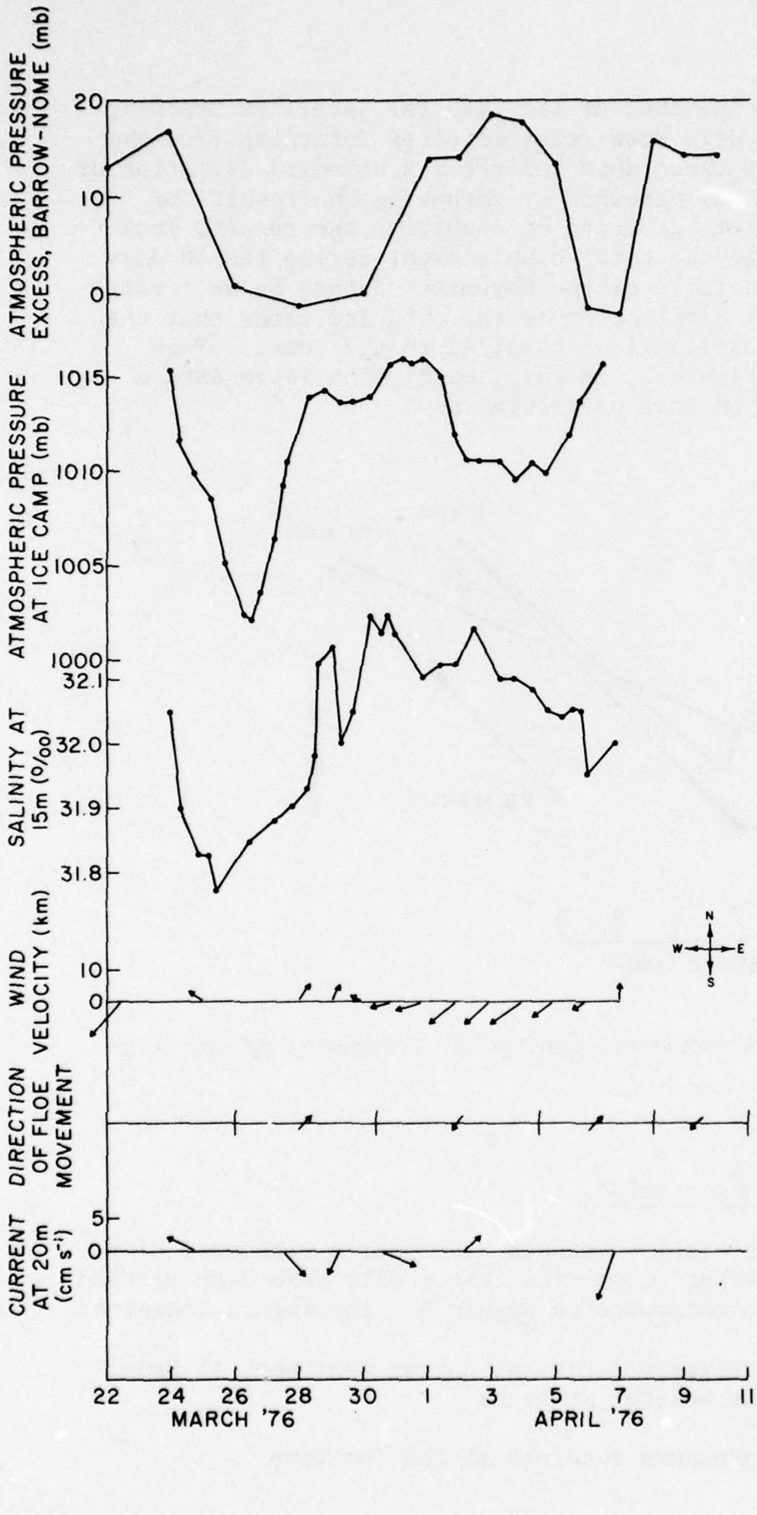

Figure 6. Comparison of atmospheric pressure, current, floe movement, and salinity change at Ice Camp APLIS. Wind arrows show the direction of air movement.

(3) The salinity at a depth 15 m below the ice camp.

(4) The wind velocity as measured at the ice camp; the arrows show the direction of air movement.

(5) The direction of floe movement as indicated by the satellite navigation system.

(6) The current relative to the floe at a depth of 20 m.

Several correlations that can be observed from Figure 6 are:

(1) The movement of the floe roughly follows the direction of the wind, which tends to be southwesterly when the pressure excess is high and northeasterly when it is low.

(2) High excess pressure corresponds to a decreasing salinity and low excess pressure to an increasing salinity. The salinity near the surface is much less in the Arctic Ocean than in the winter Chukchi Sea; with high pressure in the area, which has previously been found to relate to water movement southwestward, the lower salinity water would move toward the ice camp.

(3) The relative current measured below the floe is usually much greater than the floe's speed, and thus closely approximates the true current. The currents do not seem to be related to the pressure changes and the floe movement, except that the direction reverses about the same number of times.

OCEANOGRAPHIC SURVEY ALONG THE COAST

Review

Oceanographic measurements in the Marginal Ice Zone of the Chukchi Sea (see Figure 7) during the last 5 years have shown that the coastal area from Pt. Hope to Pt. Barrow is very active, especially in the summer when the coastal current moves water rapidly from Bering Strait to the Arctic Ocean. The existence of appreciable currents in other seasons has been suspected from examination of satellite photographs. Verification of these currents was obtained in 1973 by Mountain,[12] who measured currents in the Barrow Canyon in the spring and found axial flows as high as 50 cm/sec in both directions.

Temperature and salinity measurements northeast of Pt. Barrow in the spring of 1975 revealed an uprising of Atlantic water into the Barrow Canyon; beyond the lower end of the canyon was near-freezing water with a salinity of 34‰ which was ascribed to drainage from the Chukchi Sea through the Barrow Canyon.[5] The waters off the mouth of the canyon and in the canyon itself contained varying proportions of the two water masses.

A survey by icebreaker in July 1975 along the coast from Bering Strait to Wainwright revealed a bottom layer of unusually warm water 10 m thick (-1.5 to 0°C) with salinity of about 33‰.

In the spring of 1976, an oceanographic survey was made by helicopter to obtain more information on the water exchange along the coast. The specific goal was to trace the Chukchi Sea drainage and the uprising from the Arctic Ocean southwestward along the coast as far as Wainwright. This section describes these measurements, discusses what they revealed about the movement of the Chukchi Sea drainage and the influence of the Arctic Ocean in the vicinity of the Barrow Canyon, and considers several theories for the warm bottom layer found in July 1975.

The Measurements

Procedure

In early April 1976, the APL lightweight CTD profiler was lowered through holes drilled in the ice to obtain vertical profiles of temperature and salinity. An FH 1100 helicopter was used to carry the instrument and two operators from station to station. The positions of the stations, as determined by radio direction finder using radio stations at Barrow, Wainwright, and Cape Simpson, are plotted in Figure 8. Because the radio fixes were only accurate to about 5 km, the positions have often

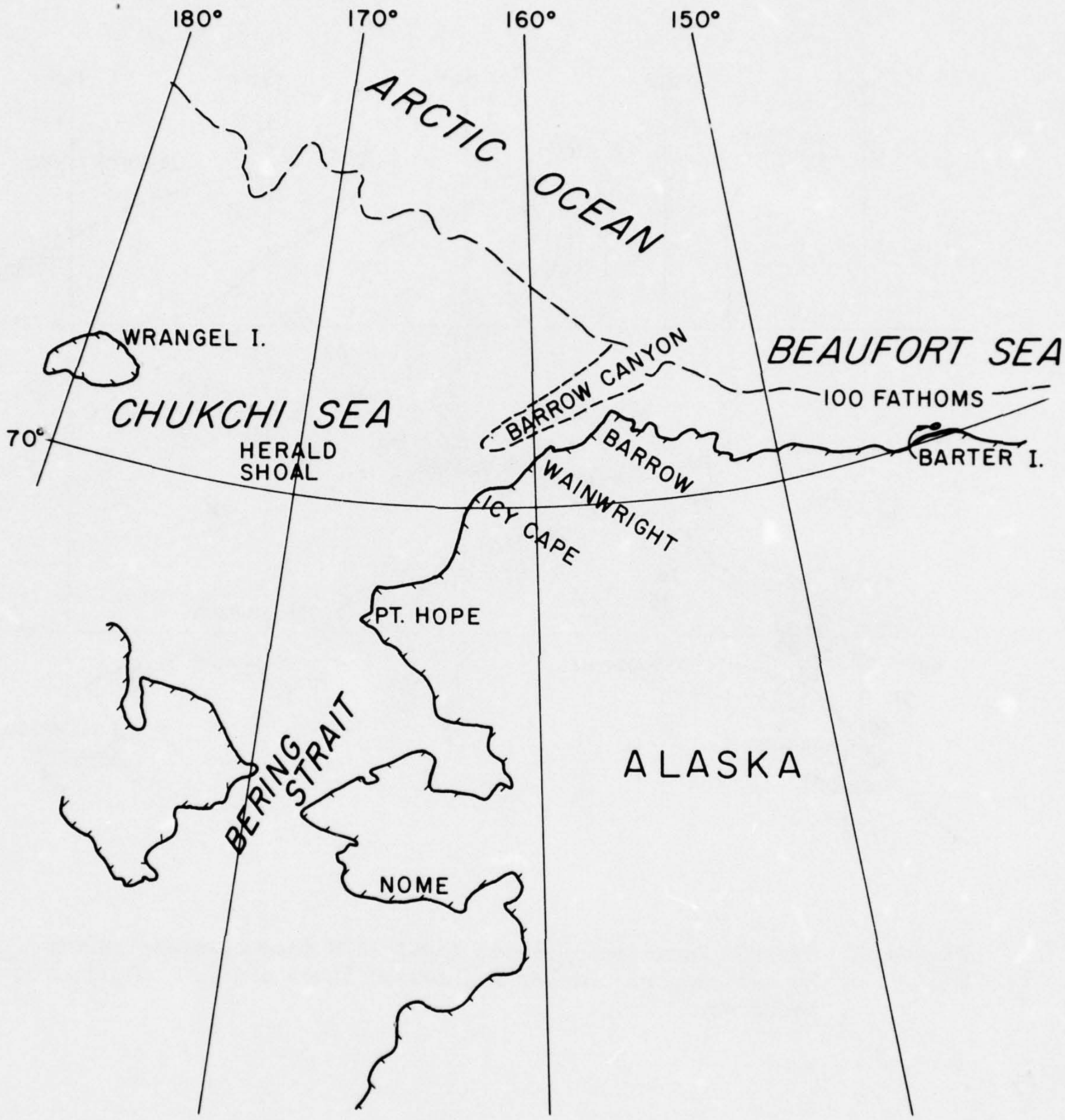

Figure 7. The location of the Barrow Canyon off the northwest coast of Alaska. The canyon slopes from the shallow Chukchi Sea into the depths of the adjacent Arctic Ocean.

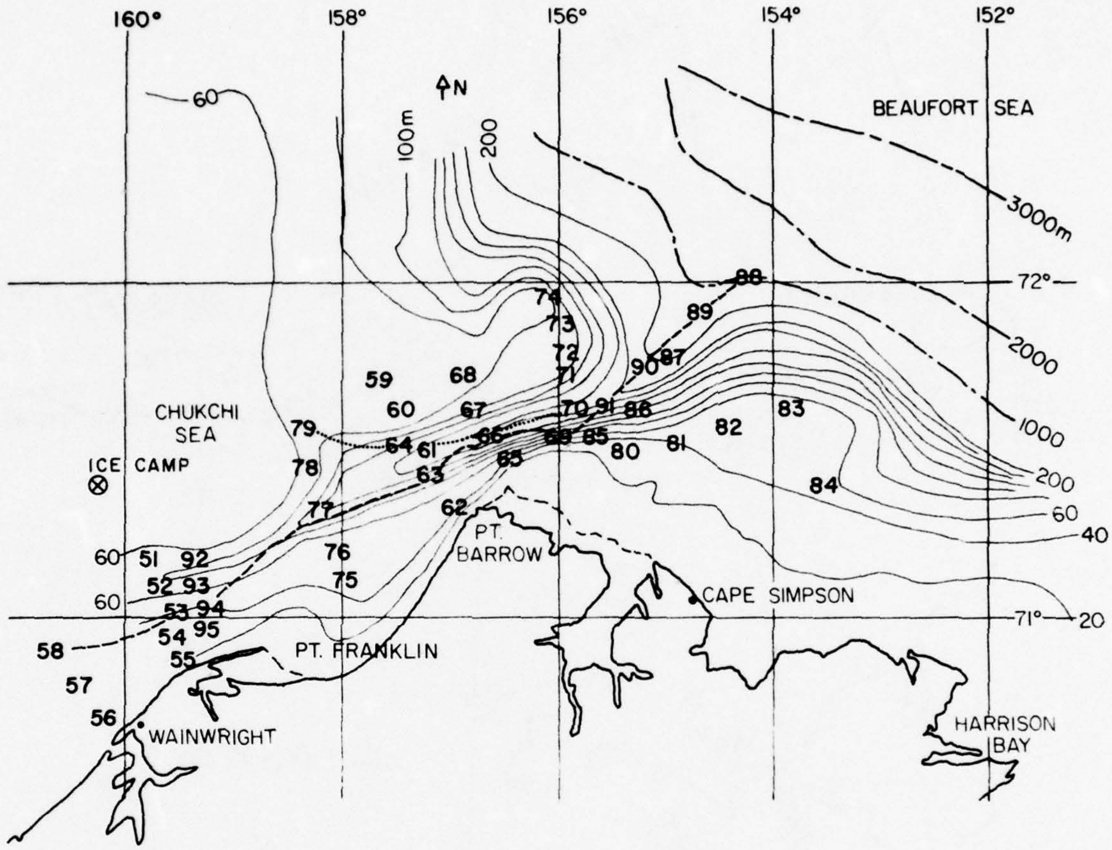

Figure 8. Station locations for the April 1976 oceanographic survey by helicopter. Dashed and dotted lines are for longitudinal sections.

been adjusted so that the measured depth agrees with the chart depth; the relative spacing along each measurement line is believed to be accurate to ±2 km. The 44-station survey commenced on 2 April 1976 and was completed on 11 April. On the last day, two current profiles were obtained at Stations 92 and 94 off Pt. Franklin.

Calibration

The conductivity sensor was checked against Nansen bottle samples near the beginning of the survey, and the temperature sensors were calibrated prior to the field trip and checked after return to Seattle. The plotted results are believed to be accurate to within 1 m of depth, 0.05°C in temperature, and 0.1 ‰ in salinity.

Data Processing

Temperature, conductivity, and depth data were digitally recorded on magnetic tape. When the helicopter returned to base (the ice camp or Barrow), the taped data were processed to obtain plots of the vertical temperature and salinity profiles. Current data were recorded manually at 10-m depth intervals. Current magnitude and direction were calculated later.

After return to the laboratory, some corrections were incorporated in CTD constants prior to final plotting. The corrected temperature and salinity profiles are shown in Appendix B. Sectional views were later constructed from the profiles.

Results

Water Masses

Figure 9 shows the temperature and salinity (vs depth) profiles obtained in April 1976 for Stations 92-95, off Pt. Franklin. These profiles reveal three layers with characteristic properties: a surface-cooled layer with low salinity, a warm intermediate layer with variable salinity, and a bottom layer with constant low temperature and high salinity.

Figure 10 presents sectional views of the measurement lines taken during the survey, beginning at Wainwright and progressing up the coast past Pt. Barrow. The shaded areas outline the bottom and intermediate layers, which will be discussed here. Only the bottom layer is present off Wainwright and on the line to the ice camp south of Pt. Franklin; it is sloped upward toward the coast, as are all the isohalines. The intermediate layer begins to appear off Pt. Franklin; again, the bottom layer

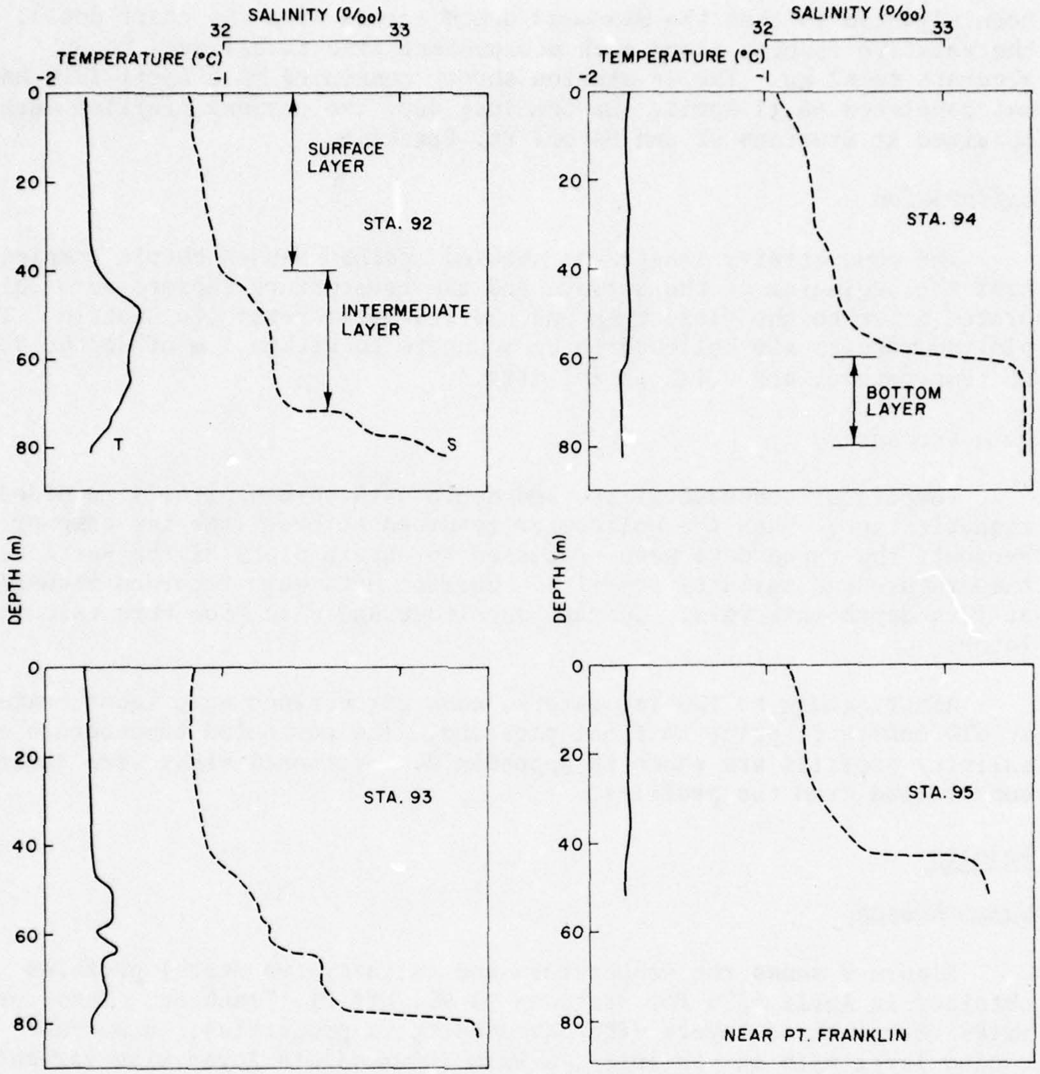

Figure 9. Temperature and salinity profiles for four stations on a line normal to the coast at Pt. Franklin. Three distinct layers are identified.

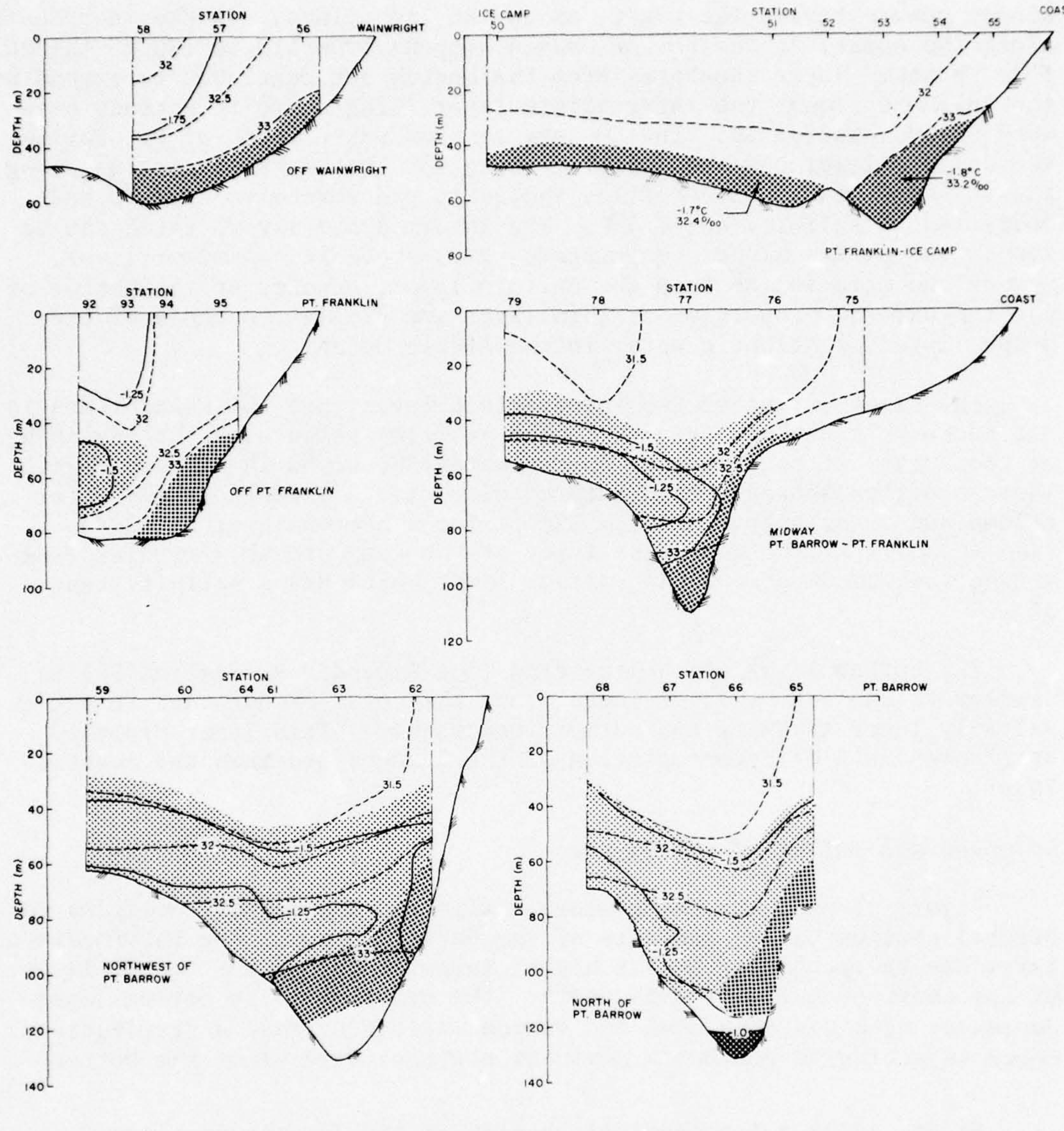

Figure 10. Sections normal to the coast from Wainwright past Pt. Barrow. The first diagram shows the bottom layer in the Chukchi Sea; the third shows the appearance of the intermediate warm layer; the last shows the warm layer of Atlantic water in the bottom of Barrow Canyon.

slopes upward toward the coast, as do the isohalines. Farther northeast along the coast, as the Barrow Canyon deepens from 110 to 130 m, the uniform "bottom" layer separates from the bottom but continues to extend up the in-shore slope; the intermediate layer lying above it extends seaward beyond Station 59. In the last section taken north of Pt. Barrow, the uniform layer observed earlier along the bottom still remains along the in-shore side. The profiles showed it had warmed to -1.45°C and decreased in salinity to 32.8 ‰. The intermediate layer, which can be recognized by its higher temperature, lies above it. Another layer, warmer and more saline than the uniform layer, appears at the bottom of the canyon; the properties of this layer are similar to those of the deeper layer of Atlantic water in the Arctic Ocean.

The exact extent of the intermediate layer into the Chukchi Sea is not known. It was not present in the profiles taken near the beginning of the survey at the ice camp approximately 80 km north of Wainwright. Those profiles showed a temperature below -1.7°C throughout the water column and a salinity near 32‰ except for a bottom layer at 32.4‰ (see Appendix A). (The low salinity at the camp probably results from mixing with the Arctic Ocean surface layer which has a salinity near 31‰.)

The bottom layer at the ice camp (see Appendix A, Station 50) is similar to the bottom layer found along the coast except that it has a slightly lower salinity and warmer temperature. This layer probably originates in a different portion of the Chukchi Sea than the coastal layer.

Longitudinal Extent of the Layers

Figure 11 presents temperature, salinity, and density profiles for several stations along the axis of the Barrow Canyon. The intermediate layer can be recognized by its higher temperature and the bottom layer by its constant salinity with depth. The density of the bottom layer decreases with distance down the canyon indicating that a gravitational force is acting to produce a movement northeastward along the bottom.

Figure 12 is a longitudinal section of the deepest stations in each measurement line, from Station 58 off Wainwright to Station 88 at the lower end of the Barrow Canyon. The intermediate and bottom layers can be traced for long distances. The bottom layer appears to progress eastward along the bottom of the Barrow Canyon until it encounters water of similar density in the Arctic Ocean with which it mixes and loses its identity. The warm intermediate layer lies somewhat seaward of the eastward-flowing bottom layer and appears to extend into the Arctic Ocean.

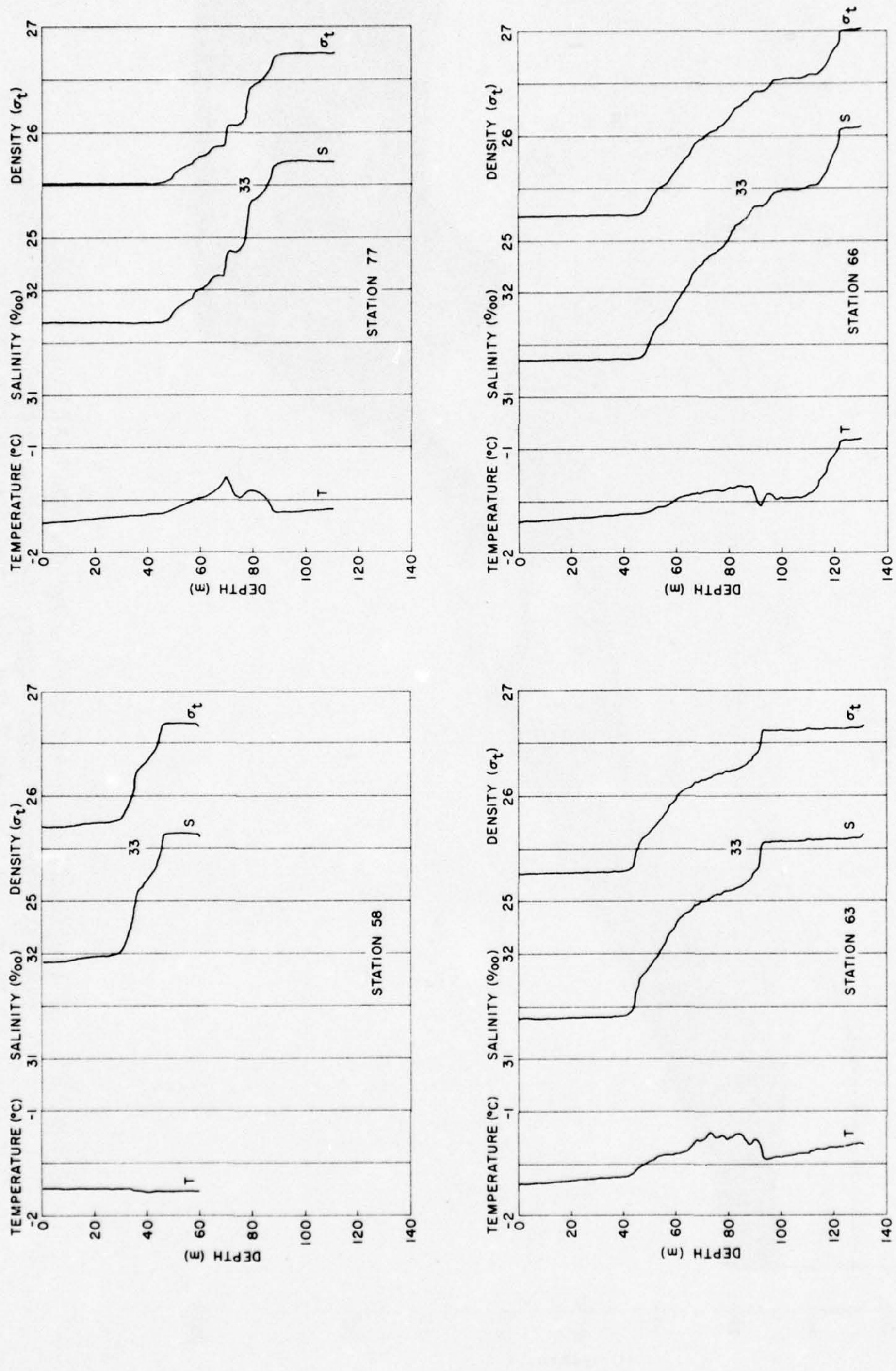

Figure 11. Temperature, salinity and density profiles for stations along the axis of the Barrow Canyon. See Figure 8 for location of the stations.

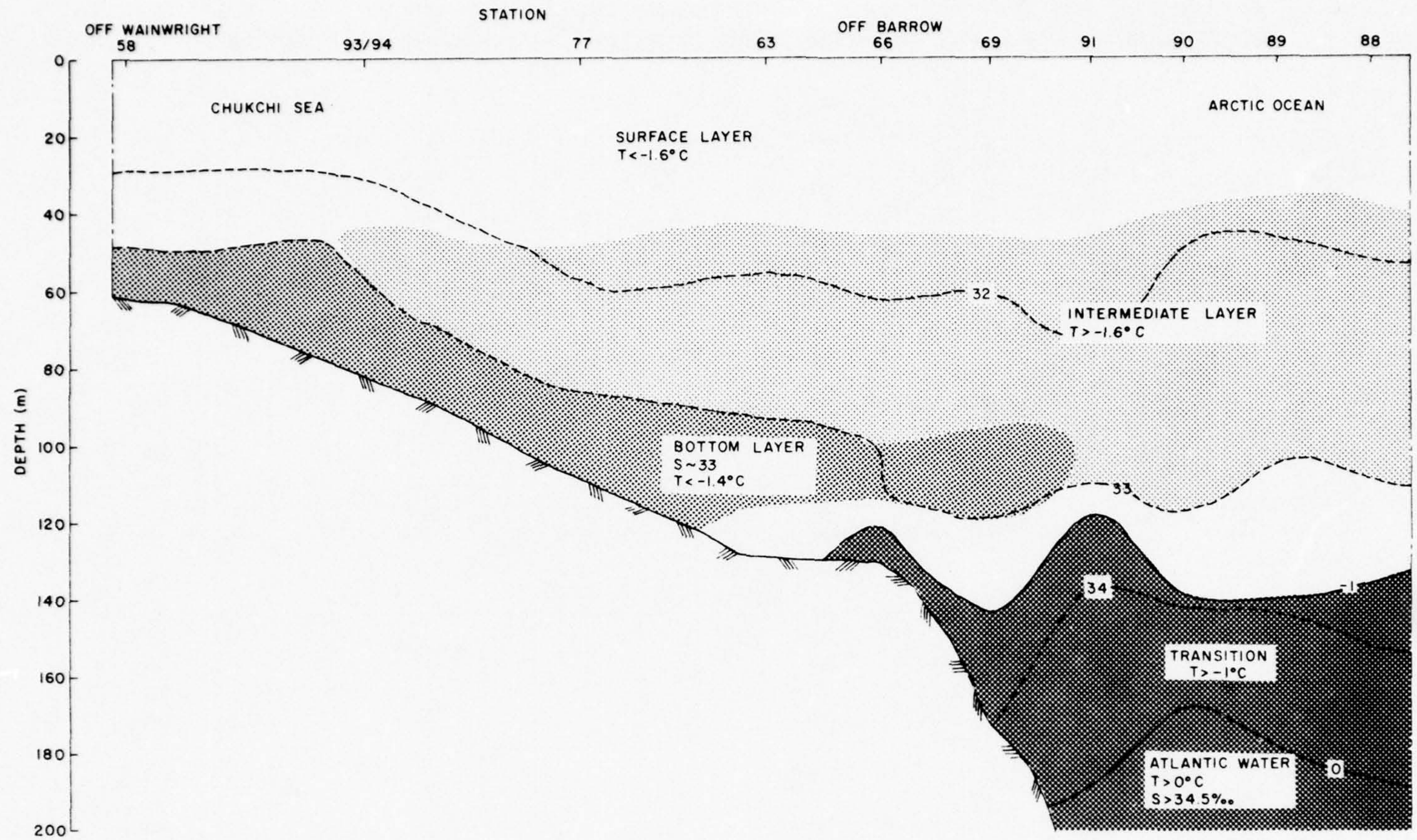

Figure 12. A longitudinal section showing the Chukchi bottom layer, the intermediate warm layer, and the transition to Atlantic water. See Figure 8 for the location of the section.

The horizontal extent of the warm intermediate layer and the colder, constant bottom layer, as determined from examination of adjacent profiles on the measurement lines, is shown in Figure 13.

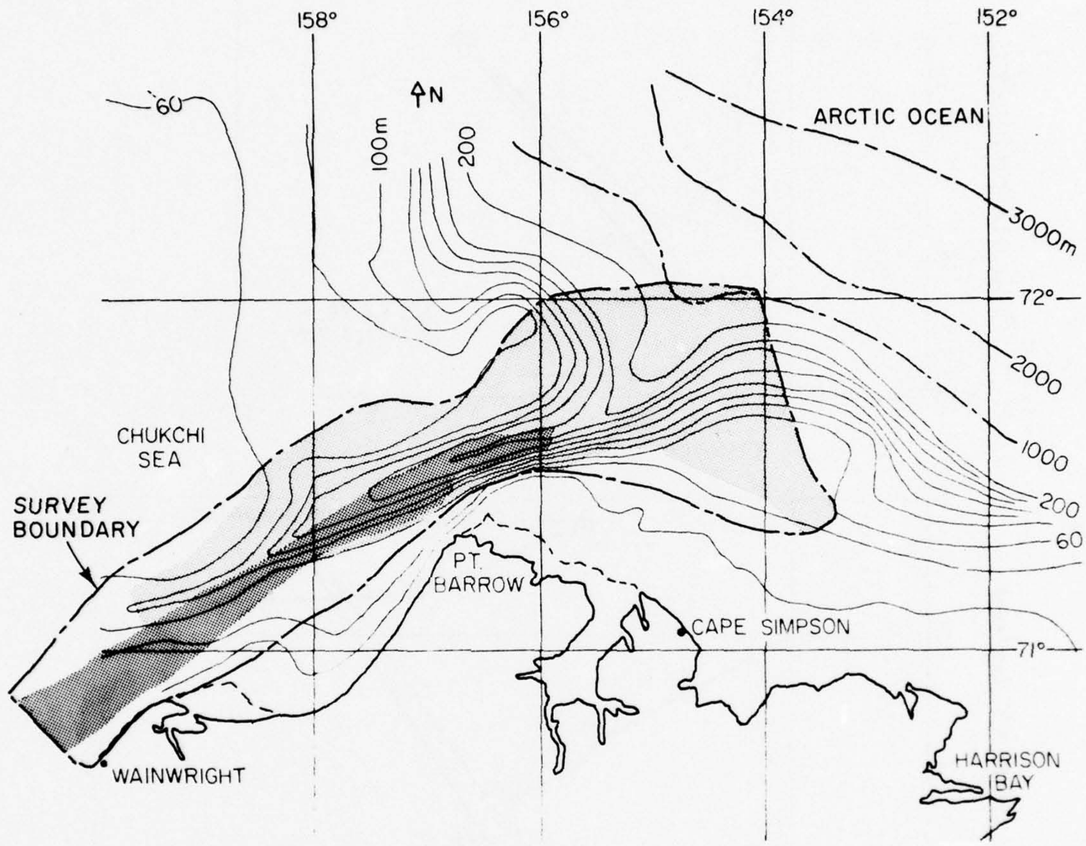

Figure 13. Horizontal extent of the intermediate layer (light shading) and the bottom layer (heavy shading).

Currents

The current measurements made at Stations 92 and 94 off Pt. Franklin are plotted in Figure 14. A comparison of this figure with the temperature-salinity profiles for these stations shown in Figure 9 indicates that a current shear occurs at the top of the cold bottom layer. The dashed arrows on Figure 14 show the movement of the bottom layer relative to the intermediate layer. The estimated stationary reference point for Station 92 occurs at the surface because the floe was in solid pack ice.

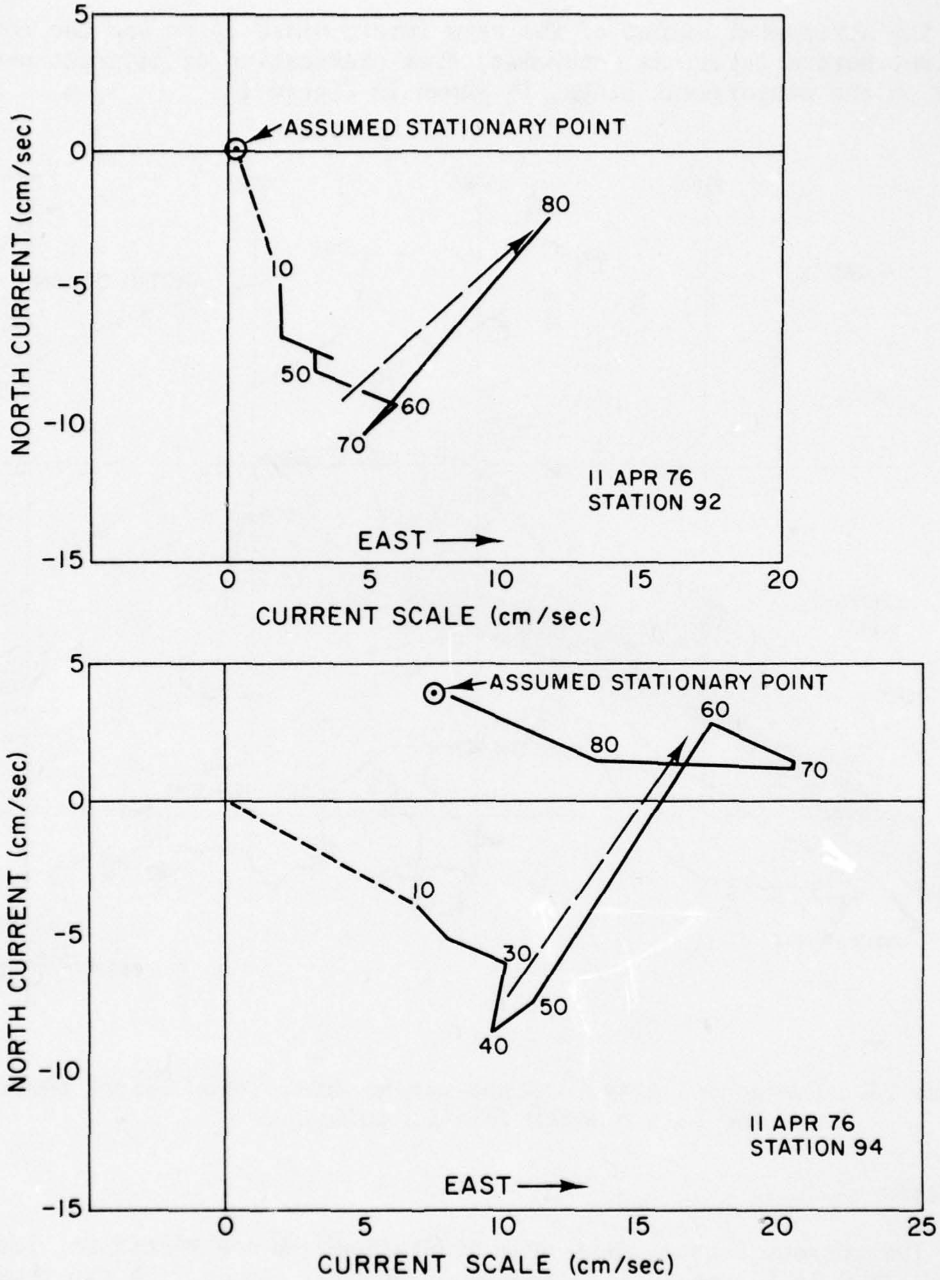

Figure 14. Current measurements from drifting ice at two locations off Pt. Franklin. The dashed arrows show the movement of the bottom layer with respect to the intermediate layer. Vectors from the assumed stationary point to the depth value represent an estimate of the current at that depth.

Station 94 was taken from a loose floe. A reading just off the bottom seems to be a good reference because it results in absolute currents in the same direction at both stations. The upper layers were moving southerly toward the coast while the bottom layer was moving easterly, with a sharp transition at the large halocline between the layers. This would indicate that most of the bottom layer was moving down the canyon with a small component moving toward shore. A longer period of current measurement would be required to verify this hypothesis.

Origin of the Intermediate Layer

The warm intermediate layer resembles the shallow "temperature-maximum layer" found in the Western Arctic Basin. According to Coachman and Barnes,[13] this layer is partially supported by water from the Bering Sea which flows along the coast and into the Arctic Ocean during the summer. During several summers, we have observed large quantities of warm water from the Bering Sea along the coast off Pt. Barrow. It would be reasonable to expect relics of this warmer water in the fall and winter and perhaps in the spring in the deep Arctic Ocean. However, in the shallow area west of Barrow, this water should cool to near-freezing during the winter. If warmer-than-freezing temperatures are observed in the spring, they would most likely result from an influx of water from the Arctic Ocean past Pt. Barrow and southwestward along the axis of the canyon. It appears, then, that the temperature-maximum layer in the adjacent Arctic Ocean, which is fed each summer by warm water from the Bering Sea, tends, in the spring, to spread southwestward through the canyon and along the coast.

The profiles for Stations 64 and 79 show extremely high temperatures (-1.05°C) at depths of 75 and 54 m, respectively. These are definitely too warm to be local remnants of the summer flow of Bering Sea water, especially following a summer with an ice-blocked coast and a correspondingly small coastal flow. Measurements in the same area in November 1975 showed only a few small pockets of water warmer than -1.0°C at the beginning of the winter.[4]

The location of the -1.05°C water at stations on an east-west line seaward of the Barrow Canyon suggests that it may have come from an uprising, or surge, of the warm water observed at a depth of 140 m at Station 88 in the Arctic Ocean. Figure 15 shows a longitudinal section from Station 79 eastward to Stations 66 and 70 near the middle of the mouth of the Barrow Canyon. The isotherms parallel the bottom but the isohalines do not, suggesting that the path upward may have been elsewhere with lateral flow into this region.

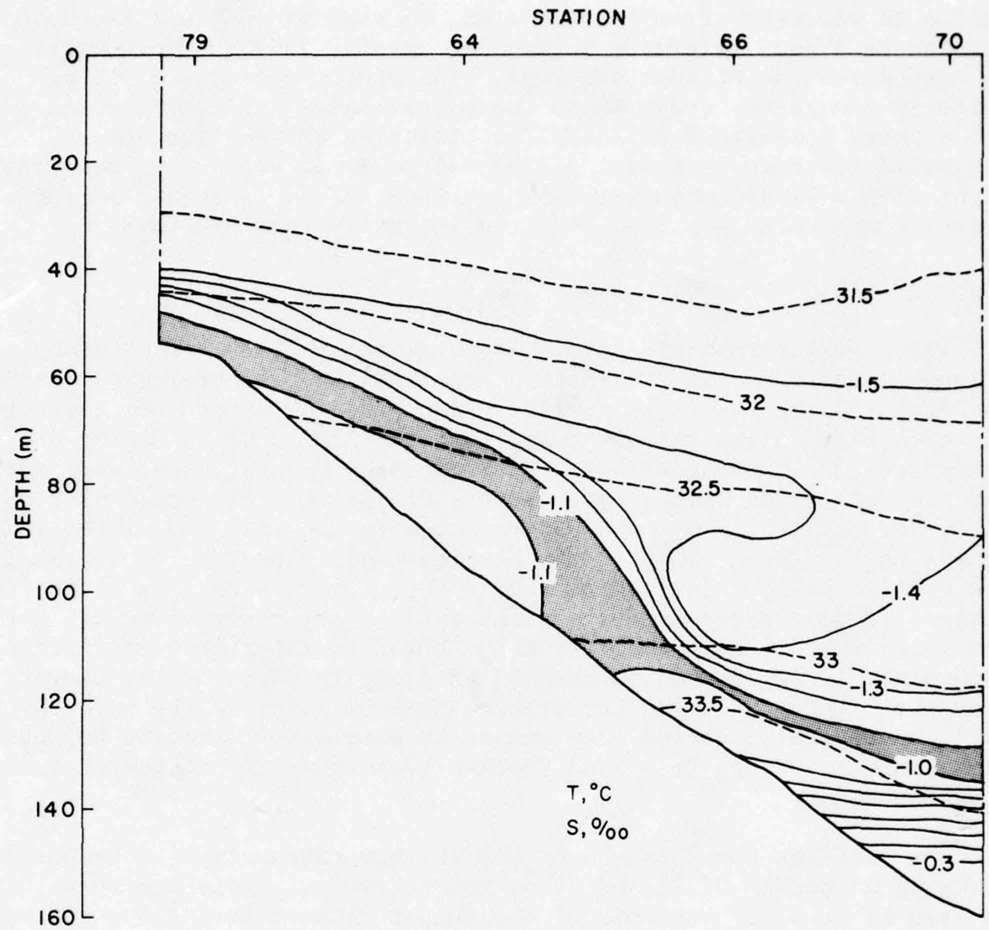

Figure 15. An east-west section (see Figure 8) connecting stations with the warmest waters. The shaded area is for temperatures above -1.1°C at stations 79 and 64 and traces the same temperature water to stations 66 and 70.

Figure 16 is a temperature-salinity diagram showing each of the layers previously mentioned, the temperature extremes at Stations 64 and 79, and the Atlantic water at Station 88, the station farthest into the Arctic Ocean. The peak temperatures found at Stations 79 and 64 lie nearly on a straight line between the warm Atlantic water and the cold surface layer, indicating that the -1.05°C water at Stations 64 and 79 could be a mixture of these waters brought about by an upward surge of Atlantic water to a depth of 40 m. The surge may have occurred 55-75 km further east where water has been observed to rise up the broad shelf from the Arctic Ocean.[5]

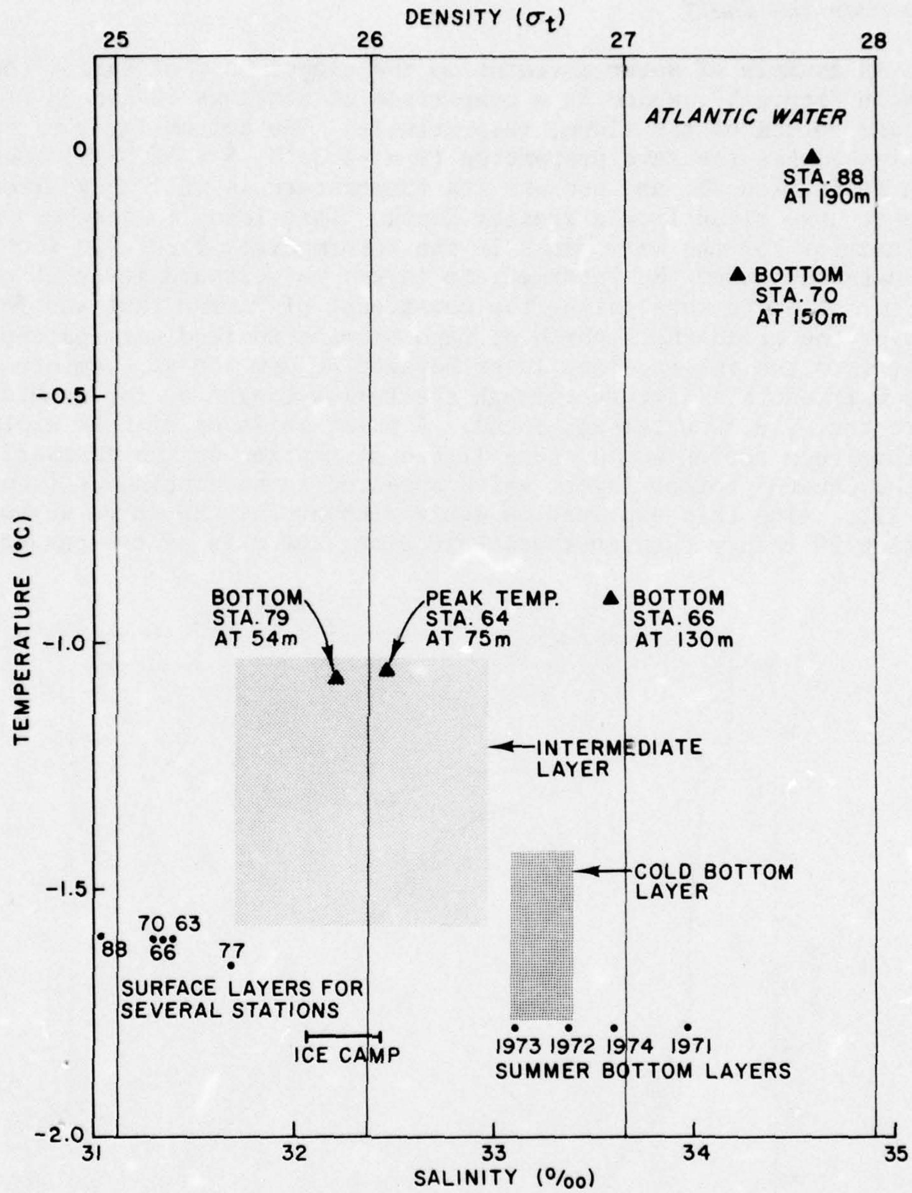

Figure 16. A temperature-salinity diagram showing all water types discussed. The warm temperature extremes lie on a line between the surface layers and the Atlantic water, indicating the possibility that they result from mixing of the two waters.

Flow over the Shelf

An example of water movement up the slopes east of Barrow can be seen in Figure 17, which is a comparison of Stations 83 and 88 at the top and bottom of the slope, respectively. The bottom layer at 40 m at Station 83 has the same properties (T = -1.33°C, S = 32.55‰) found at 80 m at Station 88, and because its temperature is well above freezing it must have risen from a greater depth. This leads to another possible explanation for the warm peaks in the intermediate layer--in fact, for the maintenance of the intermediate layer: a westward movement of deep (120 m) Atlantic water along the coast east of Barrow that was forced up over the broad shelf north of Cape Simpson to feed warm patches of water into the intermediate layer between 60 and 100 m. Momentum may have carried this mixture through the Barrow Canyon as far as Station 79, where the -1.05°C water was found. A point in favor of this explanation is that such action would cause little disruption of the eastward flow of the Chukchi bottom layer, which appeared to be continuous (see Figure 12). Also this explanation would account for the surge westward to Station 79 rather than southwestward along the axis of the canyon.

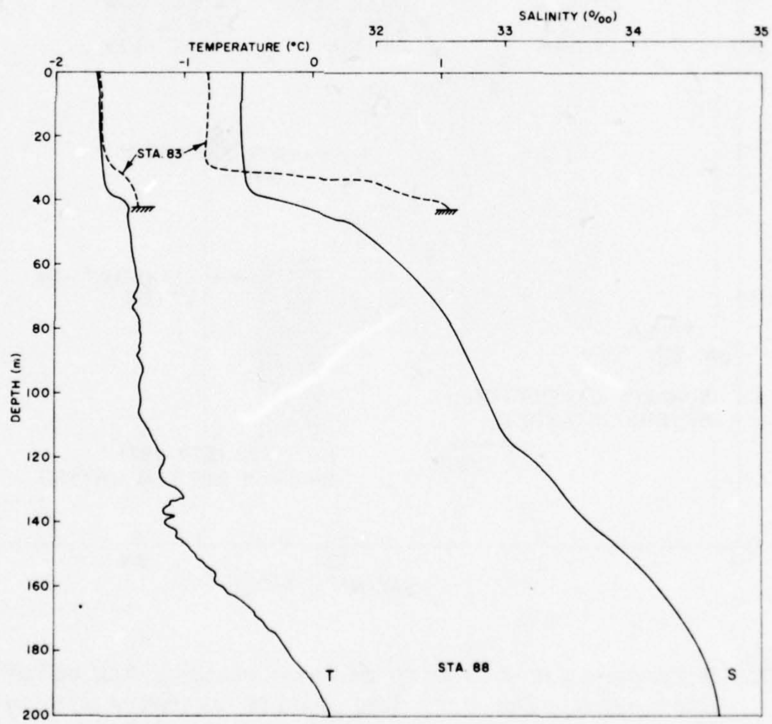

Figure 17. A comparison of a deep station profile with one on the shelf that indicates an uprising of deep water onto the shelf.

Relation to Atmospheric Pressure

Mountain[12] has shown that the flow in the Barrow Canyon is related to the difference in atmospheric pressure between Barrow and Nome. Figure 18 is a plot of the atmospheric pressure excess at Barrow for the 3 months prior to the measurements in April 1976. Assuming from Mountain's pressure-current observations that an excess pressure of 10 mb (1000 Pa) at Barrow coincides with southerly flow, Figure 18 indicates several reversals of flow which could produce alternations between the movement of the bottom layer down into the Arctic Ocean and the upsurge of Atlantic water. The excess of atmospheric pressure at Barrow from 1-4 April could have produced the surge up the canyon discussed in the previous paragraph. The sudden drop in pressure on the 5th and the 12th could have brought the cold bottom layer down the canyon, washing out some of the upsurge. These alternations would produce a continual exchange of water in the lower canyon, with some mixing and resultant loss of identity of the components.

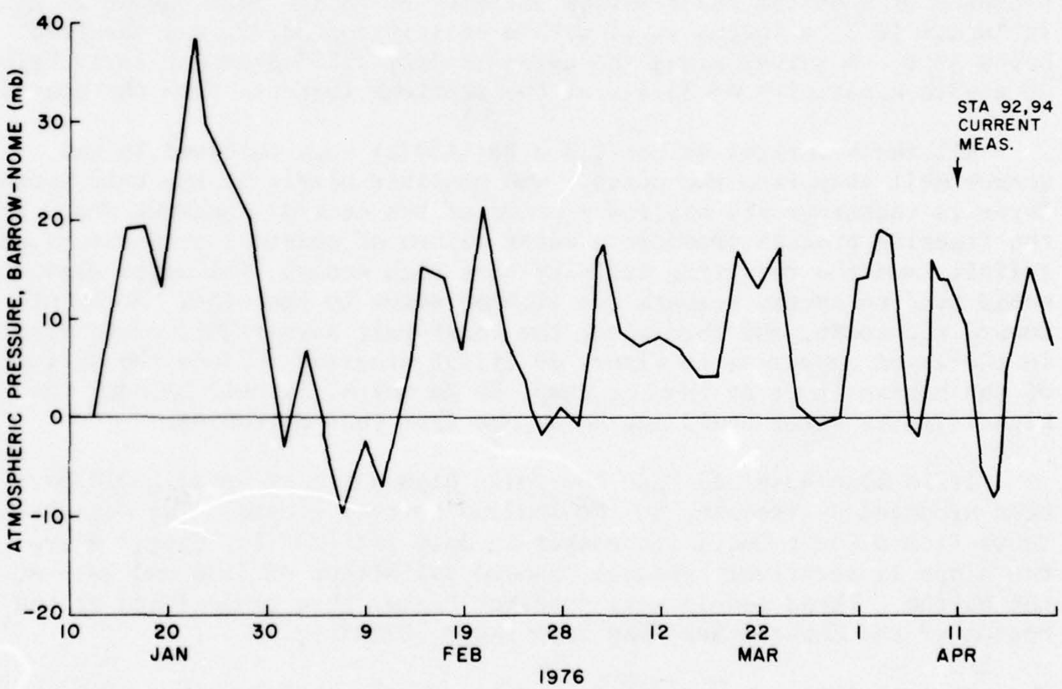

Figure 18. Atmospheric pressure differences in 1976 which appear to relate to the coastal flow.

Origin of the Cold Bottom Layer

Since the April measurements did not extend south of Wainwright, the extent of the cold bottom layer in that direction is unknown. However, the bottom layer was at near-freezing temperature (-1.8°C) and therefore very likely originated somewhere in the shallow Chukchi Sea. We present here some indications that the high salinity of this layer is also in agreement with an origin in the shallower portions of the Chukchi Sea.

A comparison of the salinity values found in the cold coastal bottom layer during this study with the values found in other salinity measurements in the Chukchi Sea since 1971 indicates that the salinity of the April layer is about the same as that found in uniform bottom layers away from the coast late in the summer. In August 1971, an oceanographic survey[1] revealed the presence of a bottom layer in the central Chukchi Sea with a salinity near 34‰. This layer generally extended from a depth of 40 m to the bottom, which is rarely deeper than 55 m throughout the Chukchi Sea. In August 1972[2] a survey showed the presence of a bottom layer with a salinity of 33.4‰ below about 25 m. In August 1973[3] a bottom layer with a salinity of 33.2‰ was observed below 30 m. A survey along the coast in July 1973[3] showed a layer below 30 m with a salinity of 33.6‰ at the stations farthest from the coast.

All these earlier values (33.2 to 34.0‰) were observed in the summer well away from the coast. One possible origin of the cold bottom layer is therefore the shallower areas of the central Chuckchi Sea. If the freezing process produced a water column of constant temperature and salinity and the resulting salinity were high enough, the water mass would tend to spread beneath the lighter water to the east. Movement toward the coast, and then along the coast past Wainwright, could result in the layer appearing in Figure 10 (first diagram). Since the salinity of the bottom layer at the ice camp, 50 km north, is only 32.4‰, the high-salinity water could not have come from that direction.

It is also possible that the cold, high-salinity water could have been produced by freezing on the shallow coastal slopes. Two measurements from a Coast Guard icebreaker in July 1975 off Icy Cape,[4] where the slope is relatively gradual, showed salinities of 33.5 and 33.6 at the bottom. These levels were somewhat higher than those found at the bottom of the Chukchi Sea away from shore (33.0‰).

Figure 19 is a hypothetical example of the salinity that could be produced during freezing along the coast. Figure 19a shows a sloping coastline covered by water with a salinity of 31.2‰ throughout. If a

1-m thick layer of ice with a salinity of 5‰ forms on the surface and there is no lateral mixing, the average salinity in the water below the ice will increase to the values shown in Figure 19b. The excess salt displaced during the freezing will tend to settle. If it all settles below mid-depth, as shown, for example, in Figure 19c, the result would be a bottom layer with an average salinity of 33.6‰, which is an increase of 2.4‰ above that of the original water. Further settling and spreading of the high-salinity water could produce an extensive bottom layer along the coast.

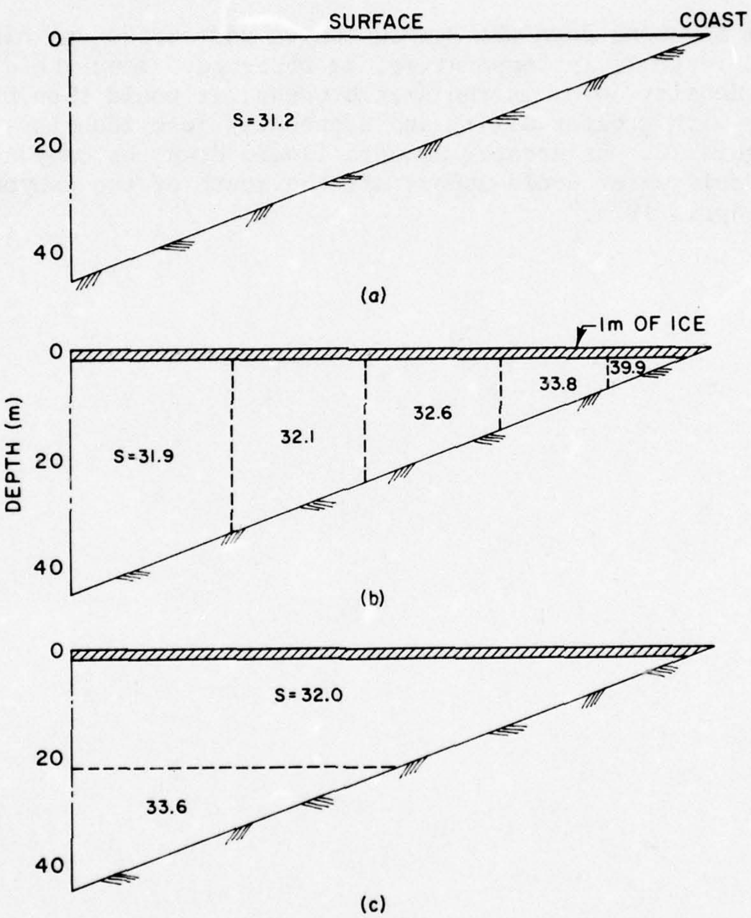

Figure 19. Hypothetical stages in the formation of a high-salinity bottom layer off the coast: (a) assumed initial fall condition, (b) salinity values resulting in each section when the surface freezes, (c) the increased salinity in the lower half if the higher salinity water accumulates there.

The bottom layers shown in the sections for Wainwright and Pt. Franklin in Figure 10 could have been formed in this manner. The salt content is in agreement with the foregoing example, and the upward slope of the isohalines toward the shore agrees with a movement of high-salinity, high-density water from the shallows to the lower depths.

If, however, the bottom layer represents a considerable flow of cold, high-salinity water, it is more likely that it was formed in the central Chukchi Sea, and that the slope of the upper layer boundary upward toward the shore is a geostrophic effect.

Further movement down the Barrow Canyon and subsequent mixing would result in an increase in temperature, as observed. When the drainage reached its density level in the Arctic Ocean, it would then broaden horizontally with greater mixing and eventually lose identity, as indicated in Figure 12. As greater amounts flowed down the canyon, an accumulation of cold water would appear off the mouth of the canyon as observed in April 1975.[4]

SEPTEMBER SURVEY OFF BARROW

Oceanographic measurements were taken again in September 1976 to record conditions in the fall. All measurements were taken with the lightweight CTD profiler from a hovering helicopter provided by the USCGC GLACIER. Equipment and personnel were taken on board the helicopter at NARL. During the measurements, the GLACIER was in the vicinity and provided radar navigation for the helicopter. All the profiles for the September survey appear in Appendix C.

First Survey, 4 and 5 September 1976

The stations occupied during these two days of the survey, A1 to A7, are shown in Figure 20. A sectional view of the temperature and salinity values for this line is presented in Figure 21. (There may be some discrepancies between these two figures because of inaccuracies in both the radar navigation and in the depth contours.) Three water types have been shaded for emphasis: the warm intrusion from Bering Strait (T > 0°C); the cold layer extruding from the Barrow Canyon; and, in the deepest part, the warm Atlantic water (T > 0°C).

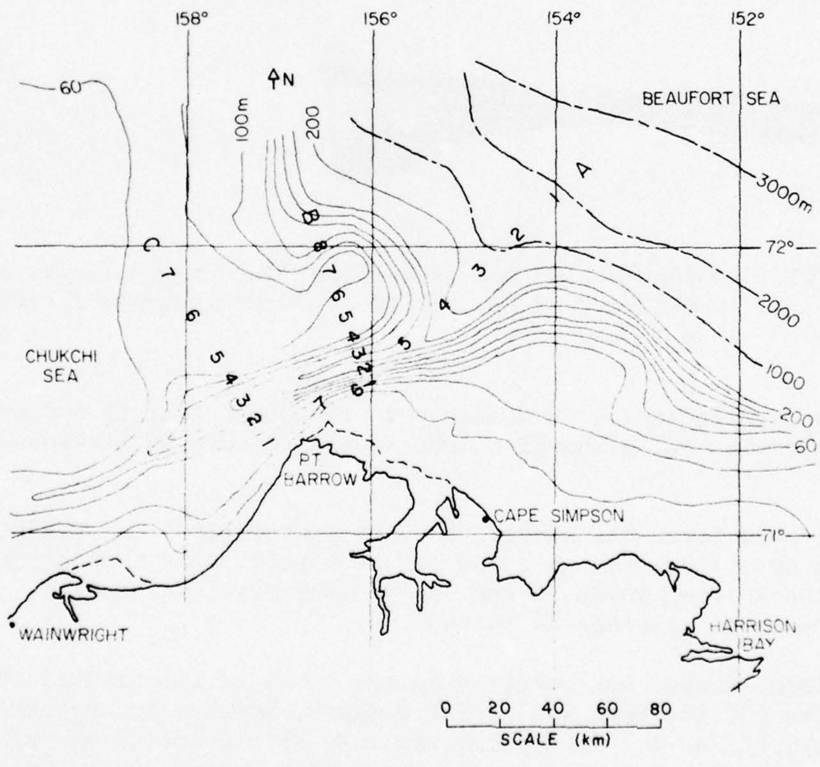

Figure 20. Location of stations for the September survey. Line A: 4-5 September 1976; Lines B and C: 19-20 September 1976.

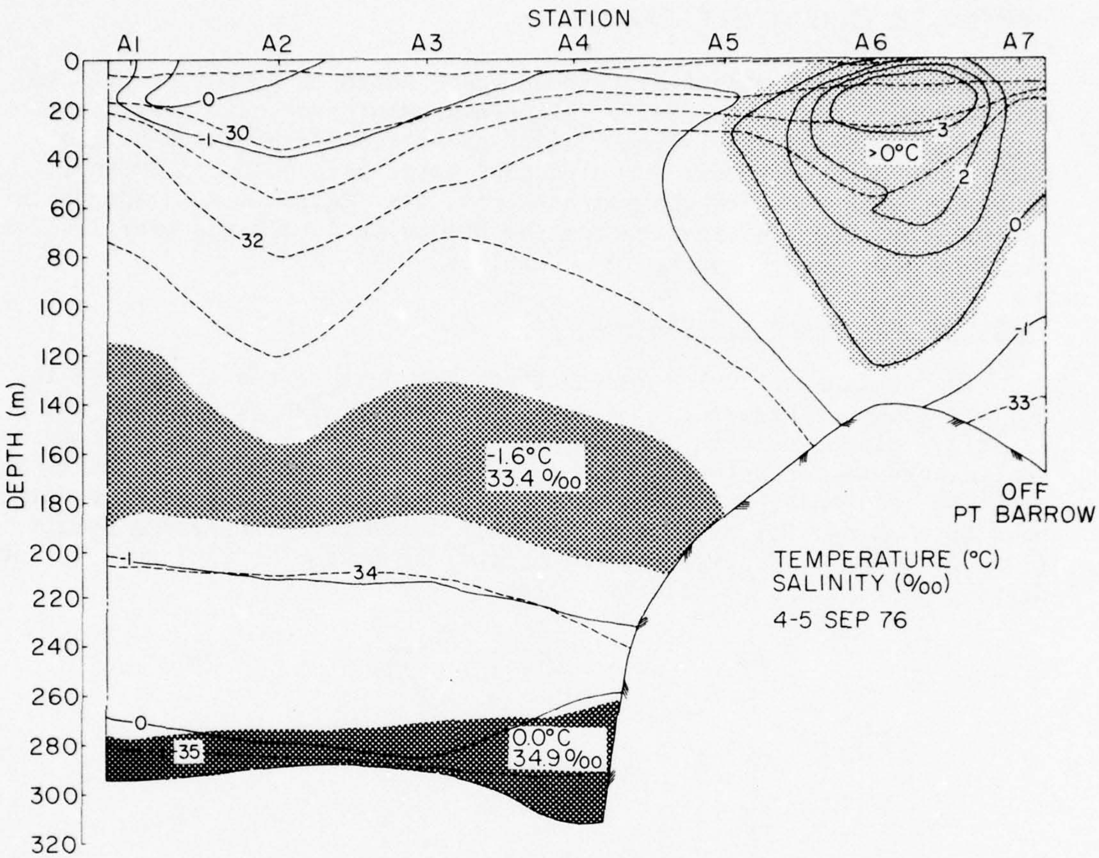

Figure 21. Isotherms (°C) and isohalines (‰) for a section taken northeast from Pt. Barrow on 4 and 5 September 1976 (Line A in Figure 20).

The warm intrusion is so close to the coast that it appears fully only at Station A6, although slight amounts extend to Stations A5 and A7.

The cold layer has nearly constant properties (T = -1.6°C, S = 33.4 ‰) that are about the same as those of the bottom layer found in the upper end of the Barrow Canyon in the spring (see previous section). This layer occurs at Stations A1 through A4.

A large change has occurred in the level of the Atlantic water. In April, the 0°C isotherm was at 180 m depth, whereas it appears now, in September, at 280 m. It appears that the summer influx of the Alaskan coastal current has forced the isothermals downward, which, with the spring uprising, may be an annual cycle.

Second Survey, 19 and 20 September 1976

After a delay for helicopter maintenance, the oceanographic survey continued with lines northward and northwestward from Pt. Barrow (Lines B and C in Figure 20). Sectional views of these lines are presented in Figures 22 and 23, again with shading to emphasize the three major water types.

The warm intrusion is not as deep in the section north of Barrow (Figure 22) as in the other two sections. On Line C (Figure 23), the westernmost of the three lines, the warm intrusion extends to 100 m, where it almost fills the canyon. In the earlier section northeastward of Barrow, Figure 21, the intrusion extended to approximately 120 m and was confined close to the shore. In Figures 22 and 23, the intrusion appears to be spreading across the surface as if the flow had ceased.

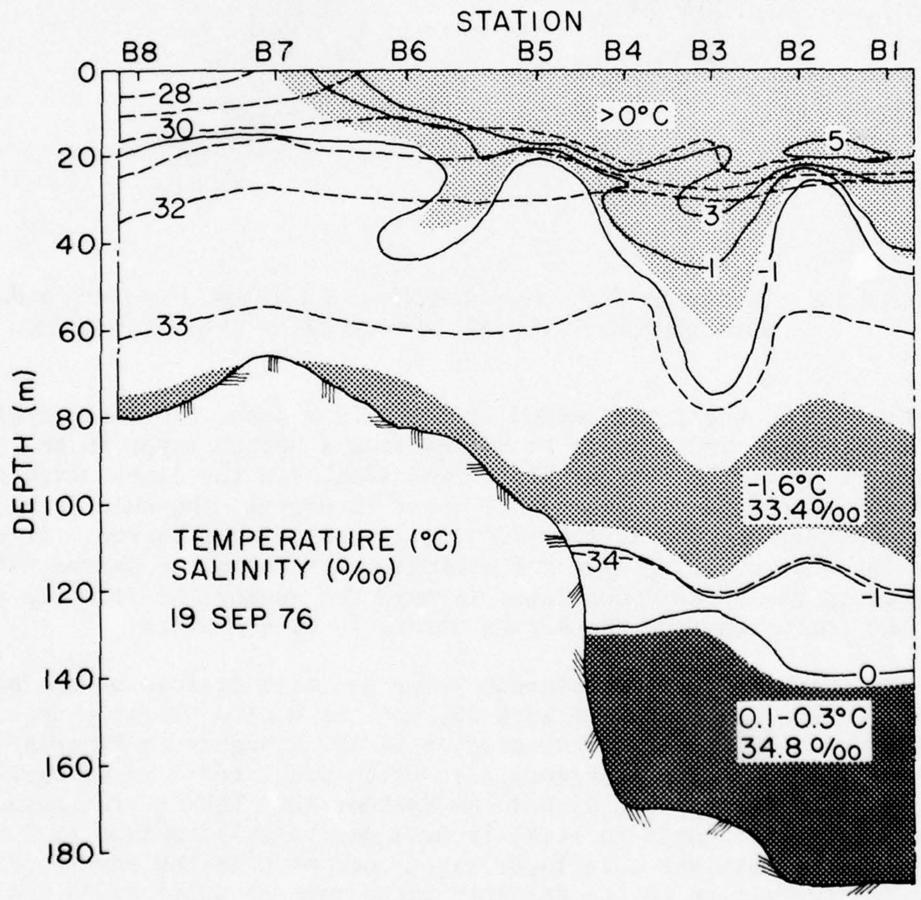

Figure 22. Isotherms (°C) and isohalines (‰) for a section taken northward from Pt. Barrow (Line B on Figure 20).

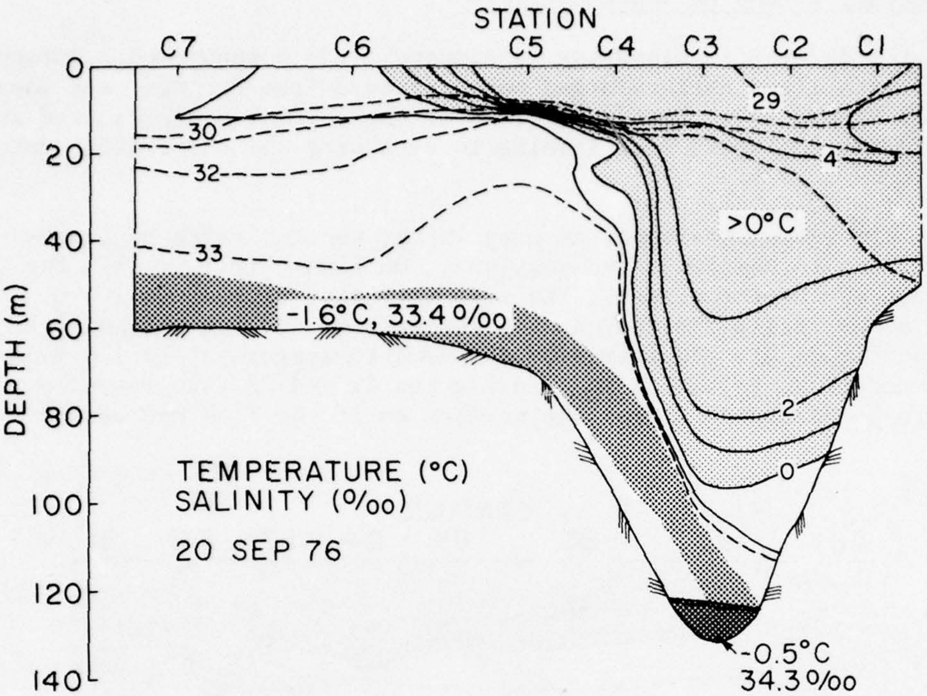

Figure 23. Isotherms (°C) and isohalines (‰) for a section taken northwestward from Pt. Barrow (Line C on Figure 20).

On Line C, where the canyon is only 140 m deep, the cold layer lies near the bottom, and appears to be fed from a bottom layer in the shallower portion of the Chukchi Sea to the west. On the lines north and northeast of Pt. Barrow, where the water is deeper, the cold layer, which is still between 80-120 m depth, is now off the bottom. It appears that the draining from the Chukchi Sea through the Barrow Canyon observed in the spring[5] continues through the summer, at least in a year when the intrusion from the Bering Strait is rather small.

The uniform layer of Atlantic water is still visible on the bottom in the section for Line C (Figure 23) but has cooled slightly to -0.5°C. The bottom layer of the Atlantic water is 120 m higher in Figures 22 and 23 than it is for Line A (Figure 21), which was taken 2 weeks earlier. However, since Line A was also 40 km farther into the Arctic Ocean, we believe that the change in level is much more a space change than a time change. Note that the cold layer rises some 90 m in the same 40 km; also, the transition to the Atlantic water seen at Stations B3 and B4 is not sharp enough to indicate a recent change.

The change in the water beyond the mouth of the canyon from spring to fall can be seen in Figure 24, which is a comparison of typical profiles in April and September. From 120 to 260 m, the water is much colder and less saline in September than it is in April. This is additional evidence of a large drainage of Chukchi Sea bottom water into the depths of the Arctic Ocean during late spring and summer.

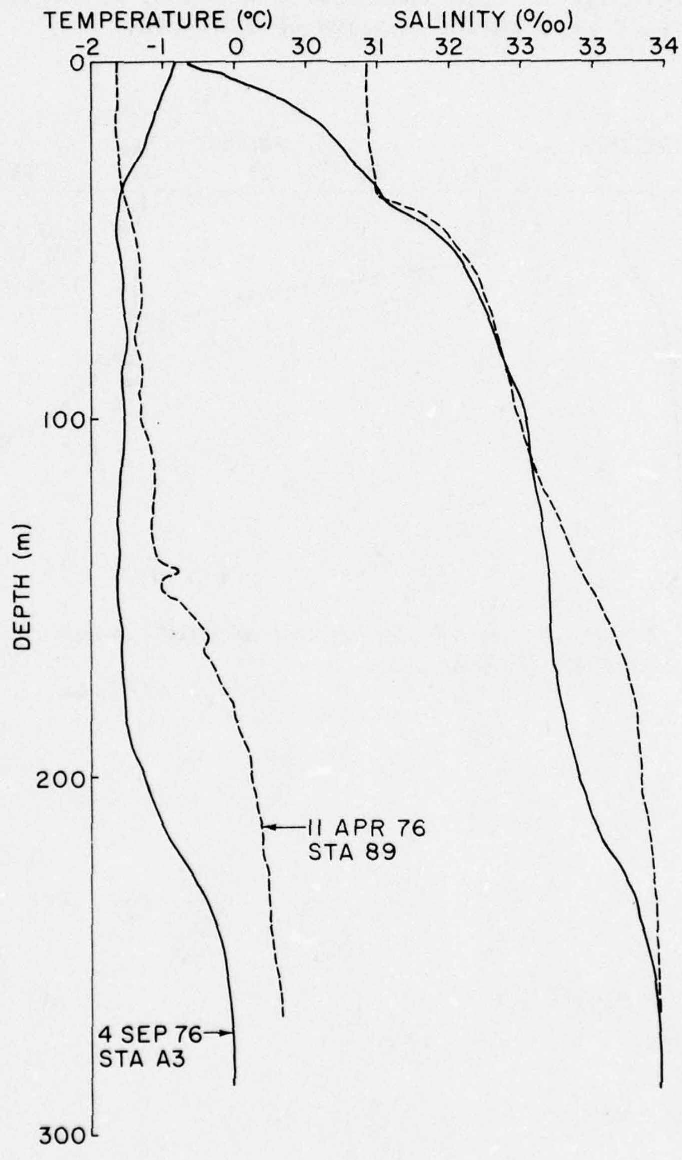

Figure 24. Comparison of typical profiles beyond the mouth of the Barrow Canyon in April and September 1976.

The change that took place between the spring and the fall in the eastern Chukchi Sea northwest of the Barrow Canyon is shown in Figure 25, which again is a comparison of typical temperature and salinity profiles. One obvious difference is the consistency of the April profiles compared to the layering that occurs in the September profiles. The most striking difference is the increase in salinity in the cold layer below 25 m in the September profiles. This indicates a movement of higher salinity water from farther west in the shallow Chukchi Sea.

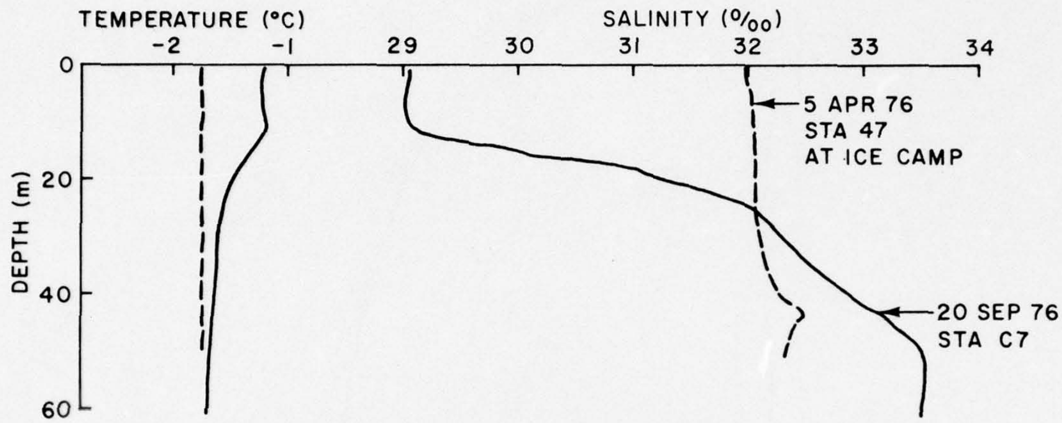

Figure 25. A comparison of the spring and fall conditions in the eastern Chukchi Sea.

MEASUREMENTS IN BAFFIN BAY

Introduction

In late February and March 1977, two men from the Laboratory participated in a cruise through Davis Strait into Baffin Bay on the USCGC NORTHWIND (see Figure 26) in conjunction with researchers from the Naval Undersea Center (now the Naval Ocean Systems Center). One operated the APL lightweight CTD profiler and the other took measurements of the reverberation from biological scatterers in the water beneath the ship. Forty-eight vertical temperature and salinity profiles were taken with the lightweight profiler; volume scattering strength as a function of depth was measured at forty-five locations. A description of the cruise and the results of the oceanographic measurements are included here. The results of the volume reverberation measurements will appear in a later report.

Trip Report

The NORTHWIND departed Bermuda for Cape Farewell, Greenland, on 14 February with one engine inoperable. The ship entered the ice pack on 22 February at approximately 63°N 57°W. Progress to the west was blocked by ice.

A series of nine stations was taken eastward across the Davis Strait starting at approximately 63°N 61°W and slanting slightly to the north (Line A, Figure 27). Two Nansen samples were taken during this transect; analysis with a salinometer indicated the lightweight profiler was reading 0.10‰ high in salinity.

After this transect, the ship stayed off Holsteinsborg, Greenland, for 4 days while the helicopters went into Söndre Strömfjord to pick up replacement parts for the engine. Seven stations (10-16 in Figure 27) were taken during the stay as the ship drifted. This was the only scientific work done because of the shallow water and ship drills. When the parts proved unavailable, the ship effected temporary repairs and proceeded northward.

From 3-7 March, the NORTHWIND cruised west into the deep basin of Baffin Bay for the acoustic transmission experiments by NOSC. To conserve power, the ship selected a course along new leads of first-year ice less than 0.5-1.0 m thick. Following those leads, the ship made very slow progress unless there was sufficient light for the helicopters to lead the way. Between 7 and 17 March, three separate ice camps were installed and removed for the acoustic transmission experiments. During this time, temperature and salinity profiles were measured both at the ship and at the ice camps.

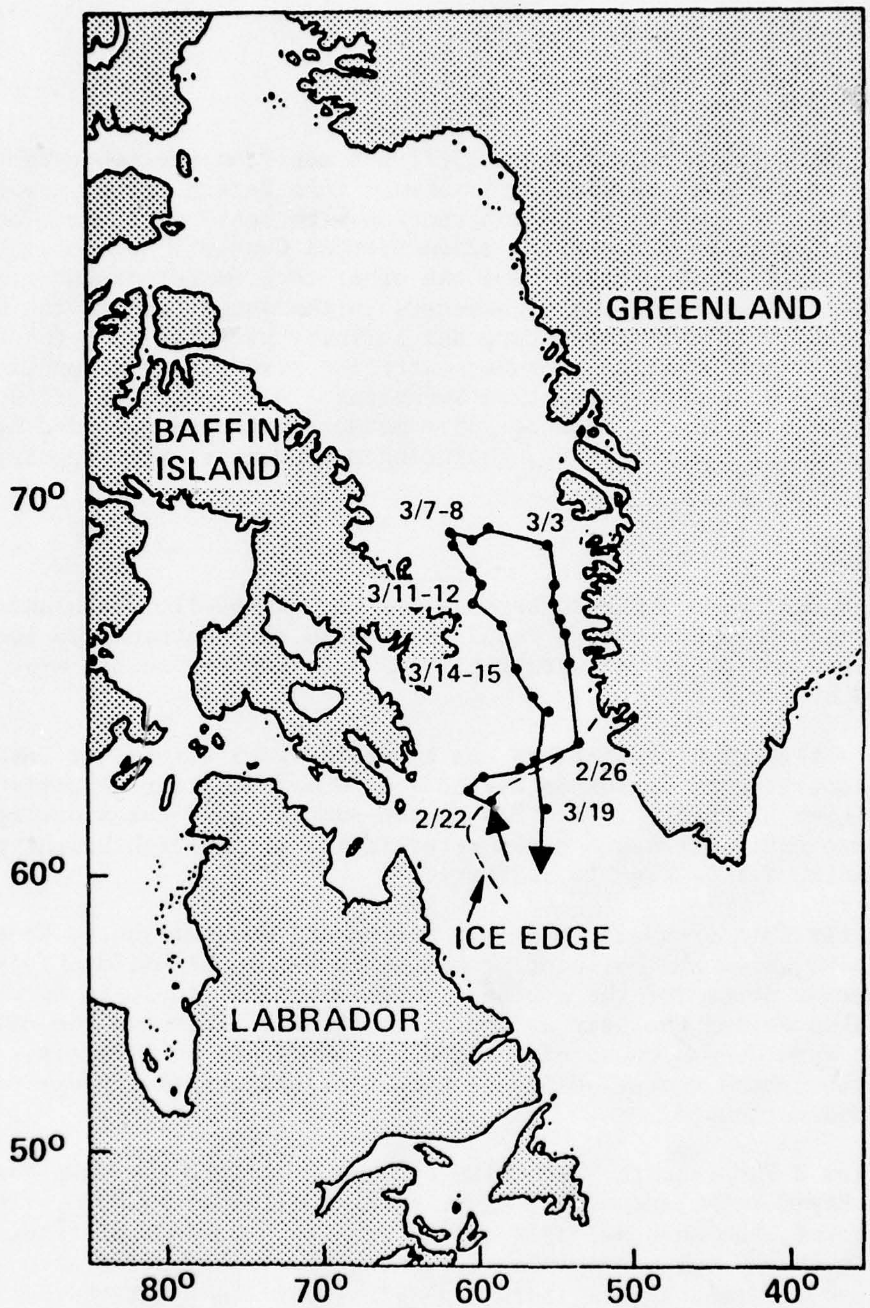

Figure 26. Cruise track of the USCGC Northwind in Davis Strait, 22 February-19 March 1976.

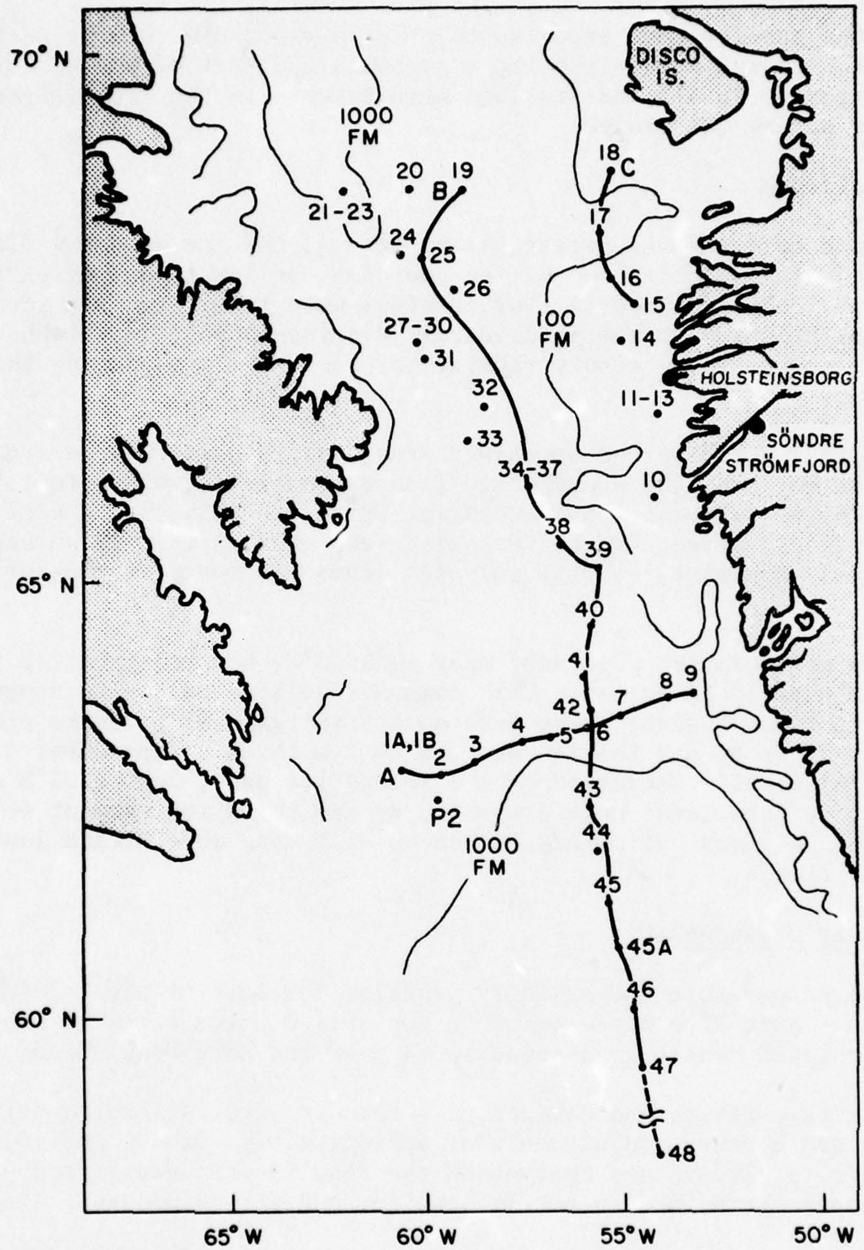

Figure 27. Stations taken in Baffin Bay and Davis Strait, 22 February-19 March 1976.

After the ice camp experiments, the ship occupied a line of stations, toward and across the ice edge south and east of the center of Davis Strait. In all, 48 stations were taken with the lightweight profiler during the cruise.

Ice Conditions

South of the Davis Strait, along Line A, the ice was very flat but relatively thin (0.3 to 1.3 m); at any time, at least ten medium sized chunks of ice* and three to four icebergs were in sight. The ice floes were continuous, with the leads barely distinguishable in thickness from the main body. There were virtually no pressure ridges during the entire crossing.

Farther north on the Greenland side, toward Disco Island from Söndre Strömfjord, the average ice floe thickness increased to 1.5 or 2 m, with the refrozen leads averaging up to 1.0 m thick. The size of the ice floes varied, but the majority were greater than 10 km across, and usually contained several refrozen leads and inactive pressure ridges.

The northernmost ice camp, near 69°N 62°W, had the greatest number of floes over 10 km across. This camp was located on a floe approximately 16 km on a side; there were no active leads or pressure ridges inside that area, and the ice was 1.5 to 2 m thick. The number of large floes dramatically decreased by the second ice camp, near 67.3°N 60°W, where large open leads were present. By the third ice camp at 66°N 58°W, the pack was noticeably broken up with many more active leads and pressure ridges.

Baffin Bay Oceanography

The temperature and salinity profiles for most of the stations shown in Figure 27 are presented in Appendix D. For a few of these, the calculated density and sound speed profiles have been added.

The temperature and conductivity sensors were calibrated prior to the cruise; however, adjustments of approximately -0.04°C and +0.2‰ have been made to give values that match the results obtained from the reversing thermometers, Nansen bottle samples, and the shipboard salinometer.

Figures 28-30 are sectional plots of the isotherms and isohalines on lines A, B, and C in Figure 27. The transverse section for line A (Figure 28) shows a warm deep layer in the central portion of the strait with colder, lighter masses on each side. It appears that the warmer

*generally less than 5 m above sea level and about 10 m across.

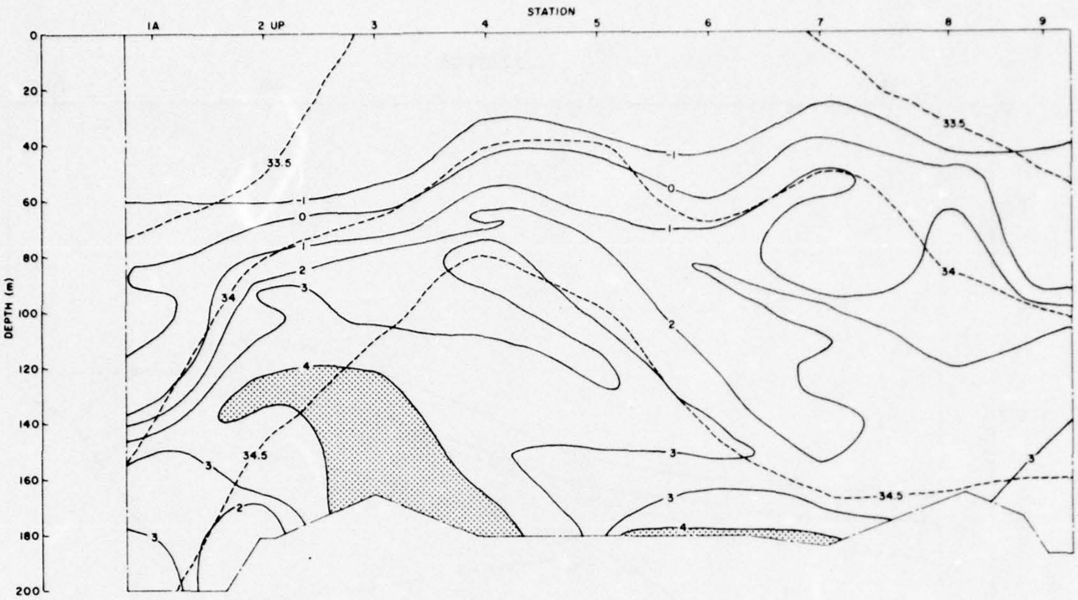

Figure 28. *Isotherms (°C) and isohalines (‰) for a section across Davis Strait (Stations 1-9, Line A). The shading indicates a temperature above 4°C.*

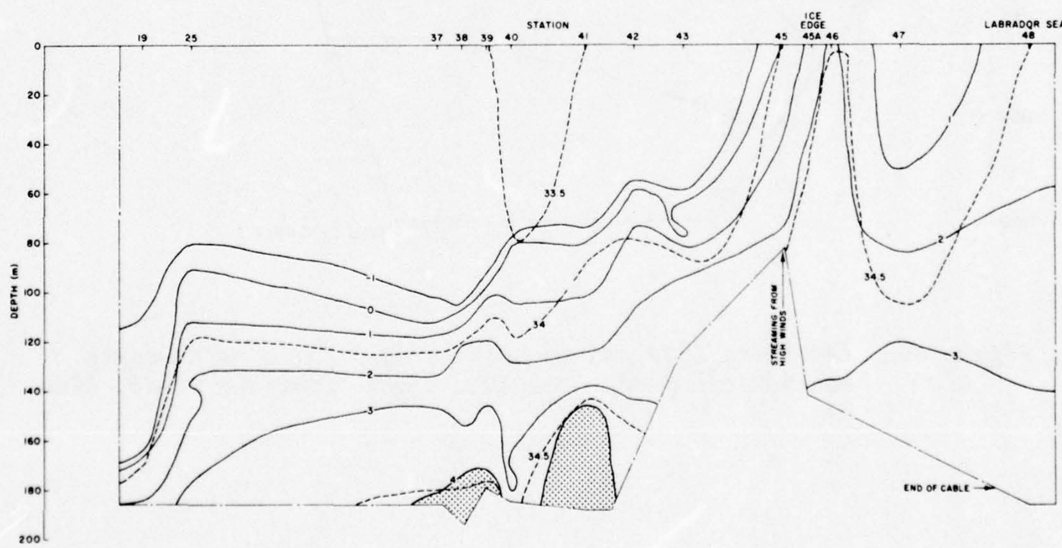

Figure 29. *Isotherms (°C) and isohalines (‰) for a longitudinal section through Davis Strait (Stations 19-48, Line B). The shading indicates a temperature above 4°C.*

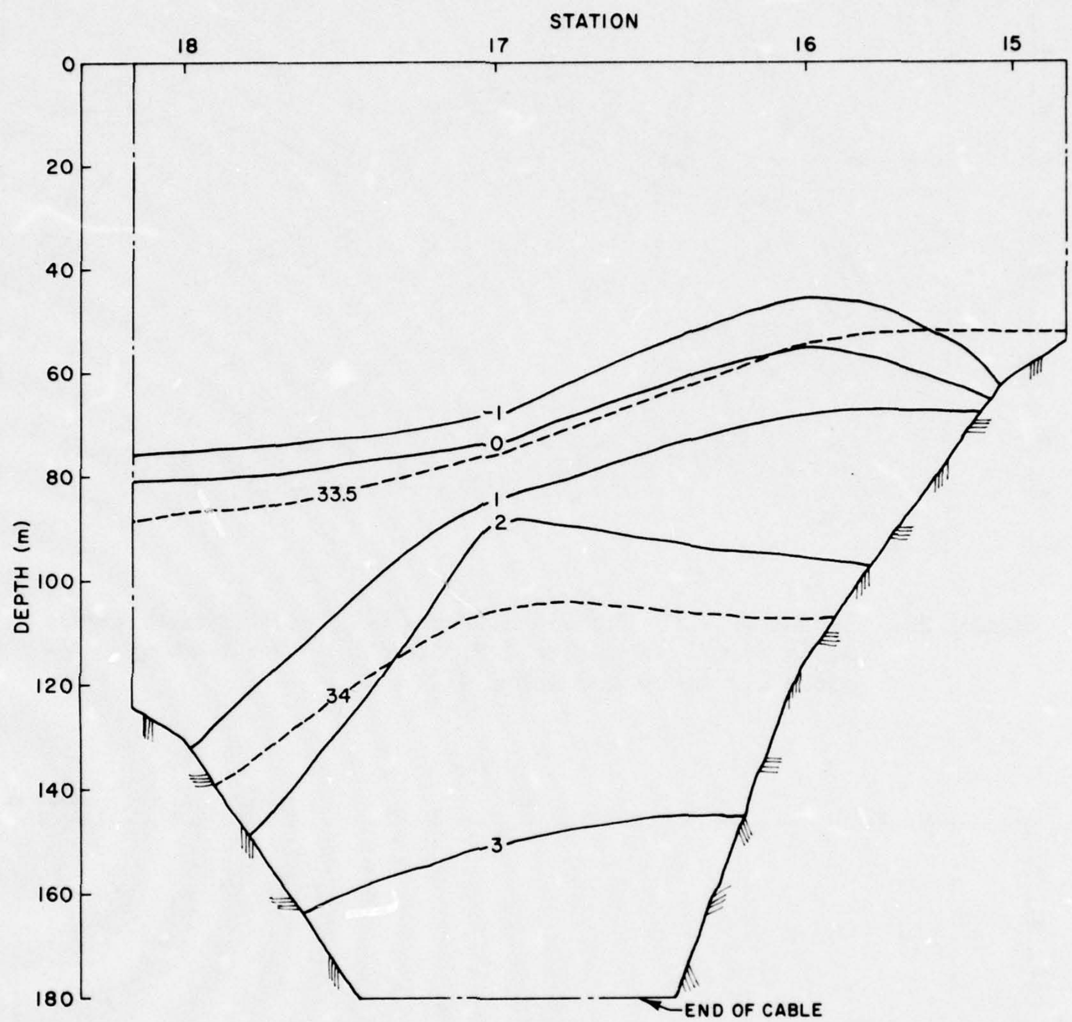

Figure 30. Isotherms (°C) and isohalines (‰) for a north-south section along the Greenland coast (Stations 15-18, Line C).

water from the deep Atlantic Ocean is extending northward and upward and that surface-cooled water is progressing southward. The longitudinal section for line B through the center of the strait (Figure 29) shows a great discontinuity at the ice edge, which lies between Stations 45 and 46. In contrast to the cold surface layer at Station 45, the water in the upper 50 m at Station 46 is well mixed and warm. (Note that for some of the southern stations outside the ice, the ship drift was so great that the cable streamed badly, reducing the depth capability.) The 4°C water at the lower depths at Station 41 probably belongs to the same water mass as the 4°C water at Stations 3 and 4 on Line A. The size of this warm mass is decreased at Station 37, and the stations farther north are probably west of it. (Unfortunately, we obtained no profiles at Stations 32 and 33.)

A branch of this central warm mass continues northward at least as far as Station 17 (Figure 30), which was the deepest portion of Line C on the Greenland side of the strait; here it has a maximum temperature of 3.4°C. The other stations along the Greenland coast showed only a near-freezing, very uniform surface layer extending to the bottom, which in this area is 90 m or less.

The northwestern profiles (see Stations 20-24 and 27-31) show very uniform water down to 80 or 90 m with a slight warming (+0.5 to 1.0°C) below that depth.

Figure 31 shows the maximum temperature at each station along with plots of the isotherms for 0, 2 and 4°C. (The northern extent of the warm central layer is uncertain because of the distance between Stations 18 and 19.)

These conditions are favorable for long-range sound propagation because the sound would be refracted upward at some depth below 40 m. However, this will usually produce a second path, which may combine with the direct path to produce large fluctuations in the received signal.

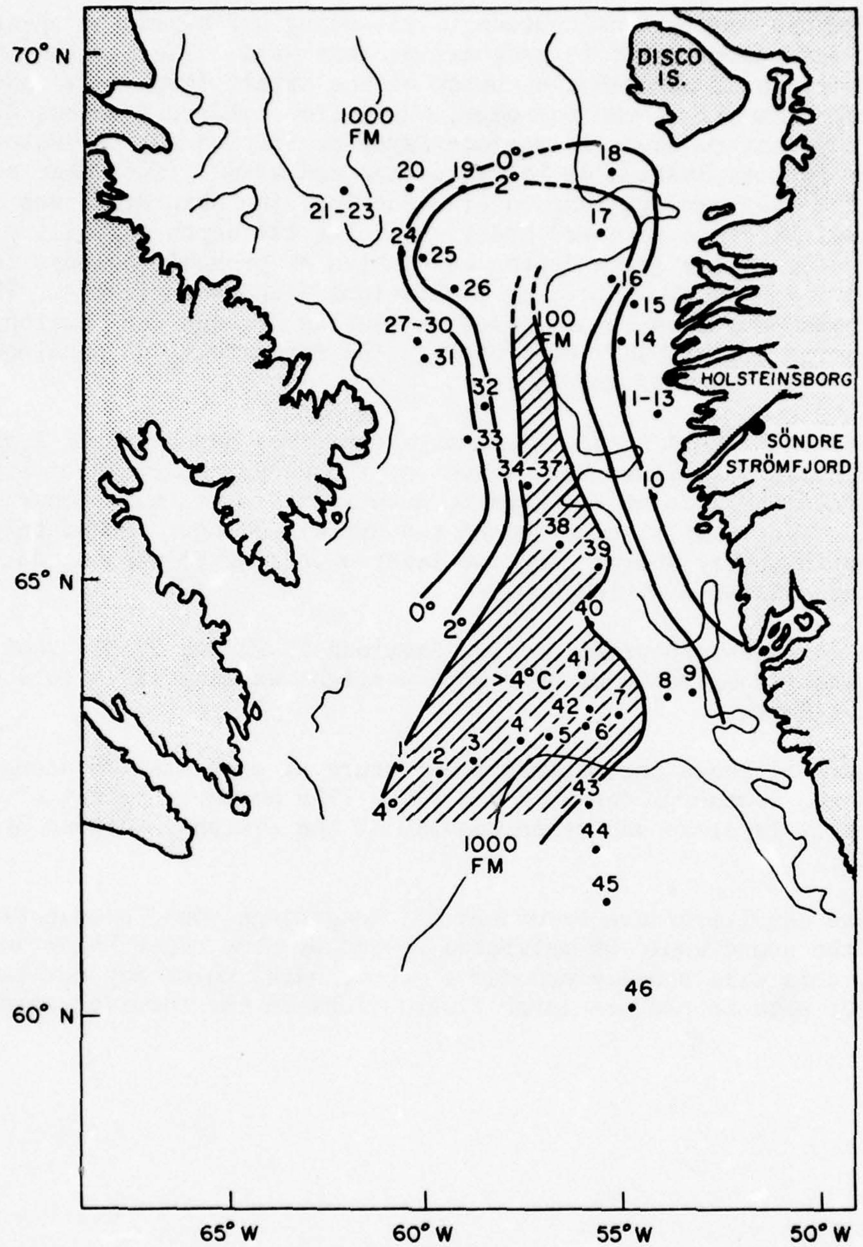

Figure 31. Isotherms (°C) of maximum temperature at each station. The cross-hatching indicates a temperature above 4°C.

ACKNOWLEDGEMENTS

These studies were sponsored by the Arctic Submarine Laboratory, Naval Ocean Systems Center, San Diego. Field support and aircraft for the helicopter flights were supplied by the Naval Arctic Research Laboratory through funding by the Office of Naval Research. Mr. Peter Becker is commended for accomplishing much of the field work under severe arctic conditions. The icebreaker and helicopter support by the USCGC GLACIER and USCGC NORTHWIND are greatly appreciated.

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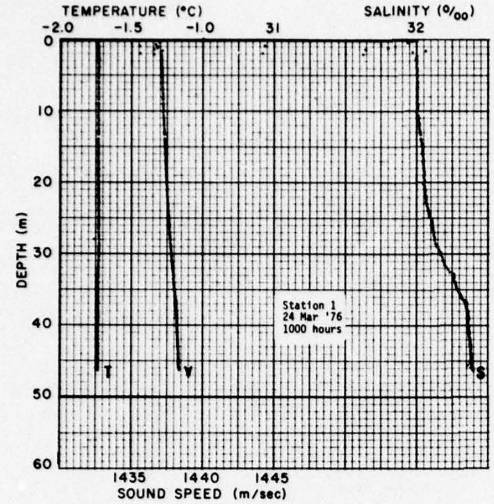
APPENDIX A

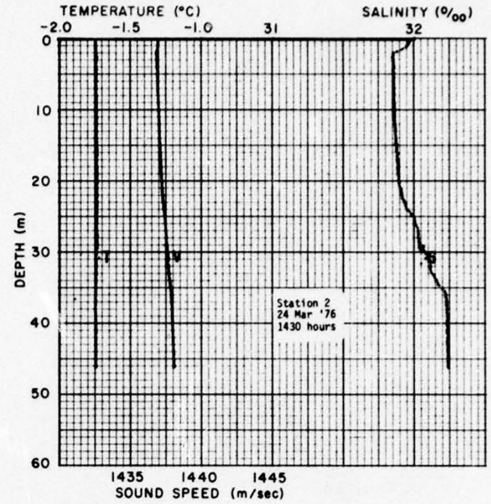
OCEANOGRAPHIC DATA AT ICE CAMP APLIS

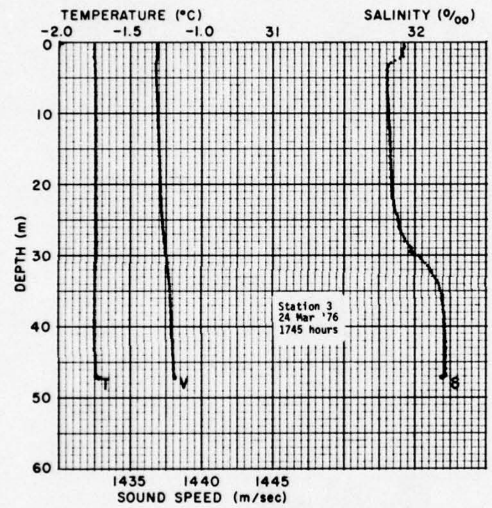
IN THE CHUKCHI SEA

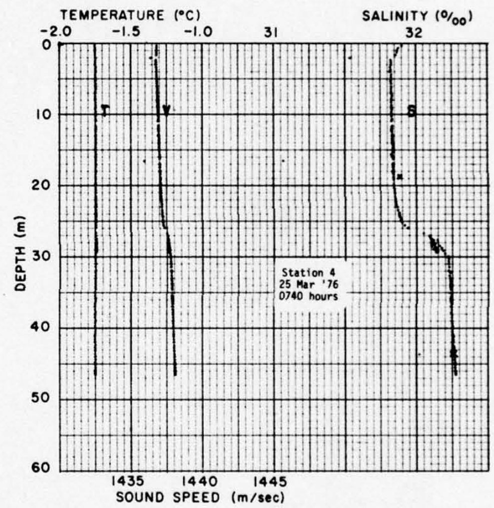
MARCH - APRIL 1976

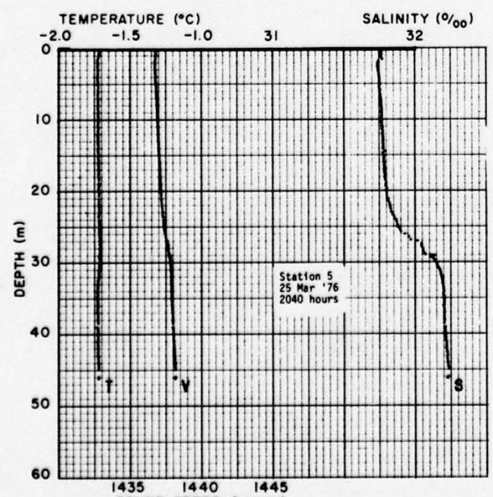
Station	Date	Time	Station	Date	Time
1	Mar 24	1000	26	Mar 31	2122
2		1430	27	Apr 1	0610
3		1745	29		1800
4	25	0740	30	2	0637
5	25	2040	42	3	2105
6	26	0800	43		2115
7	27	0930	44	4	1000
8		1830	45		2000
9	28	0945	46	5	1020
10		1925	47		2200
11		1940	49		2245
13	29	0700	50		2300
15		2030			
16		2050			
17	30	0600			
20		0730			
21		0745			
22		2000			

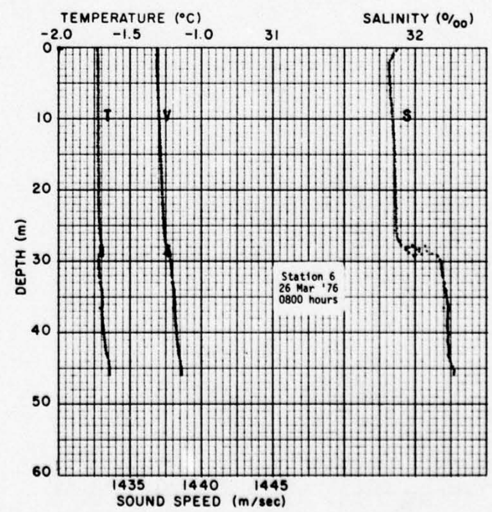

TEMPERATURE (°C)
SALINITY (‰)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
Station 1
24 Mar '76
1000 hours
T V S
1435 1440 1445
SOUND SPEED (m/sec)

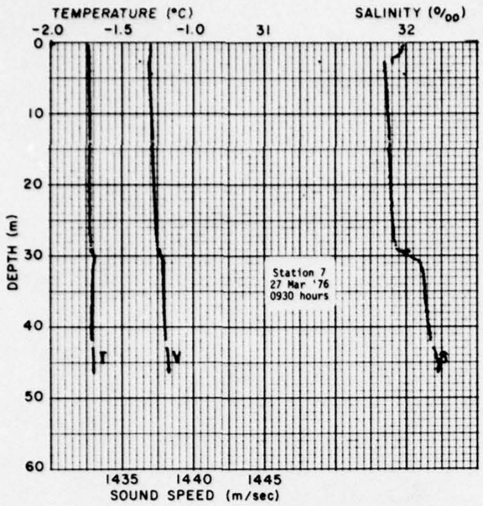

TEMPERATURE (°C)
SALINITY (‰)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
Station 2
24 Mar '76
1430 hours
T V S
1435 1440 1445
SOUND SPEED (m/sec)

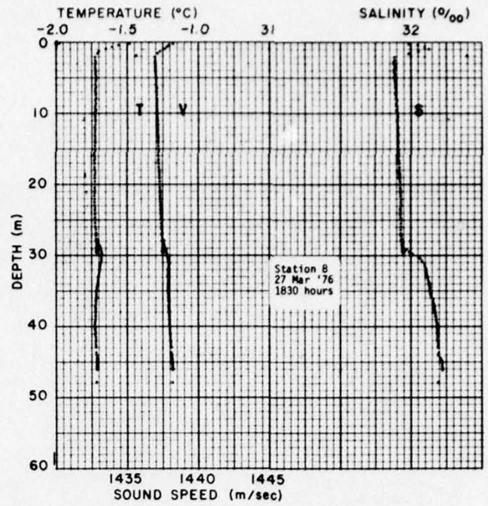

TEMPERATURE (°C)
SALINITY (‰)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
Station 3
24 Mar '76
1745 hours
T V S
1435 1440 1445
SOUND SPEED (m/sec)

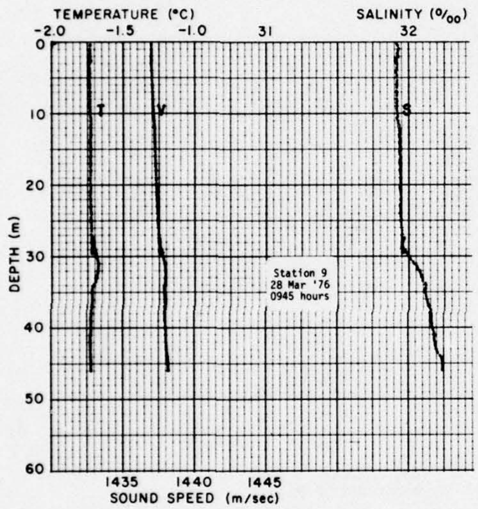

TEMPERATURE (°C)
SALINITY (‰)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 4
25 Mar '76
0740 hours
1435 1440 1445
SOUND SPEED (m/sec)

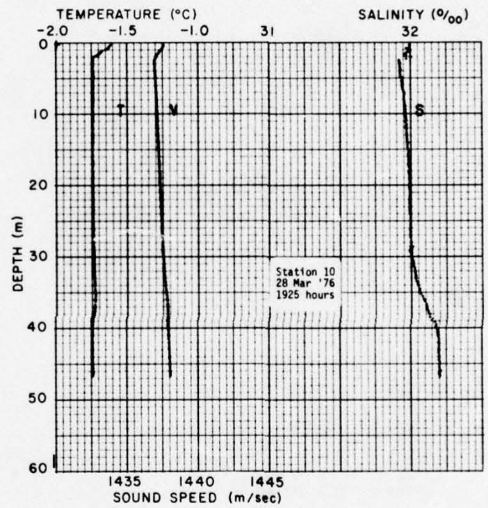

TEMPERATURE (°C)
SALINITY (‰)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
Station 5
25 Mar '76
2040 hours
T V S
1435 1440 1445
SOUND SPEED (m/sec)

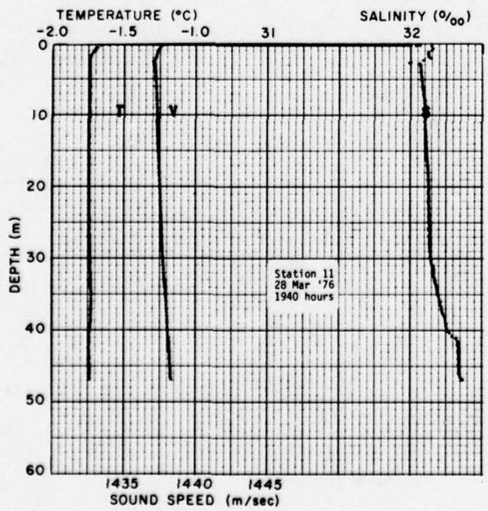

TEMPERATURE (°C)
SALINITY (‰)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 6
26 Mar '76
0800 hours
1435 1440 1445
SOUND SPEED (m/sec)

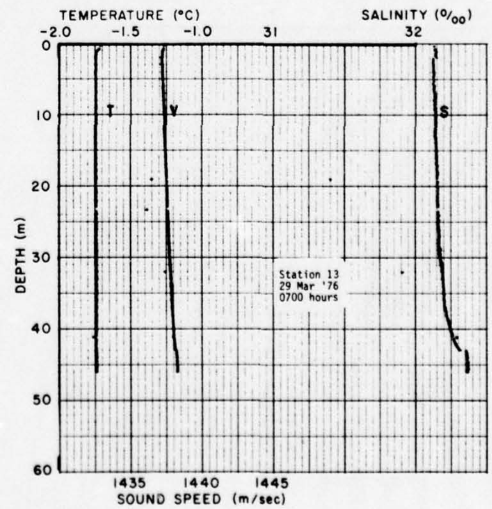

TEMPERATURE (°C)
SALINITY (0/00)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 7
27 Mar '76
0930 hours
1435 1440 1445
SOUND SPEED (m/sec)

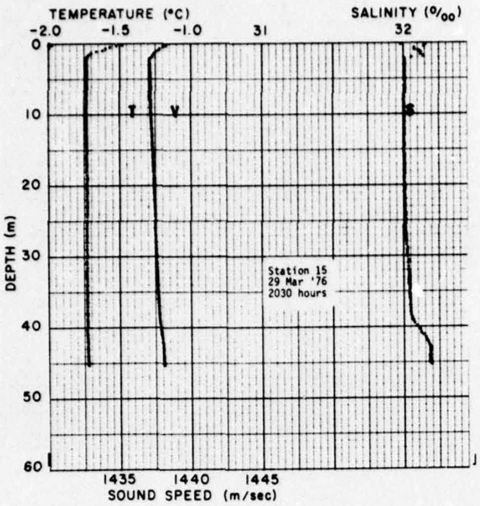

TEMPERATURE (°C)
SALINITY (0/00)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 8
27 Mar '76
1830 hours
1435 1440 1445
SOUND SPEED (m/sec)

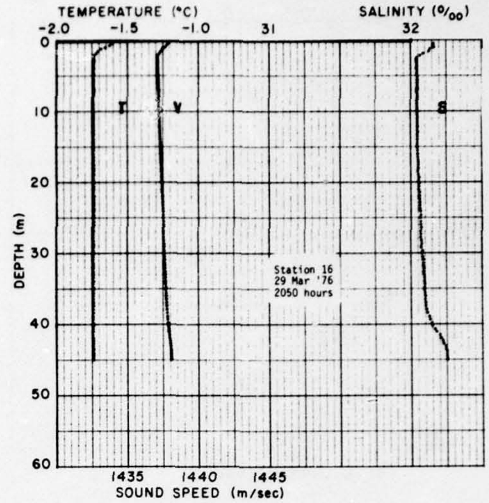

TEMPERATURE (°C)
SALINITY (0/00)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 9
28 Mar '76
0945 hours
1435 1440 1445
SOUND SPEED (m/sec)

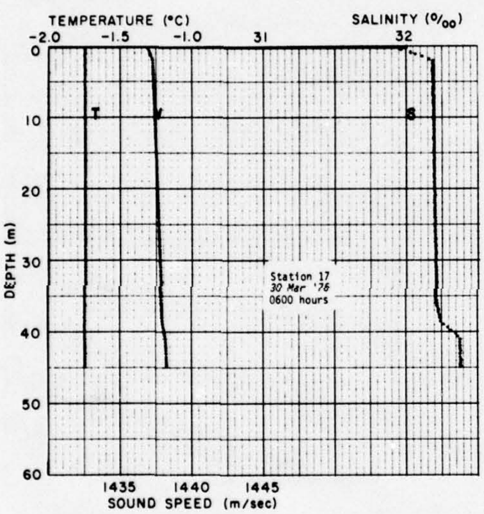

TEMPERATURE (°C)
SALINITY (0/00)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 10
28 Mar '76
1925 hours
1435 1440 1445
SOUND SPEED (m/sec)

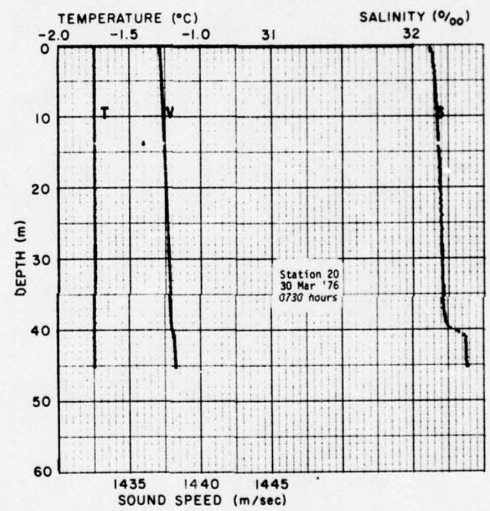

TEMPERATURE (°C)
SALINITY (0/00)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 11
28 Mar '76
1940 hours
1435 1440 1445
SOUND SPEED (m/sec)

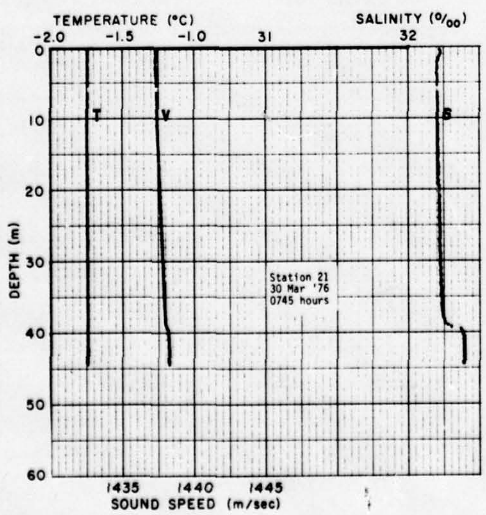

TEMPERATURE (°C)
SALINITY (0/00)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 13
29 Mar '76
0700 hours
1435 1440 1445
SOUND SPEED (m/sec)

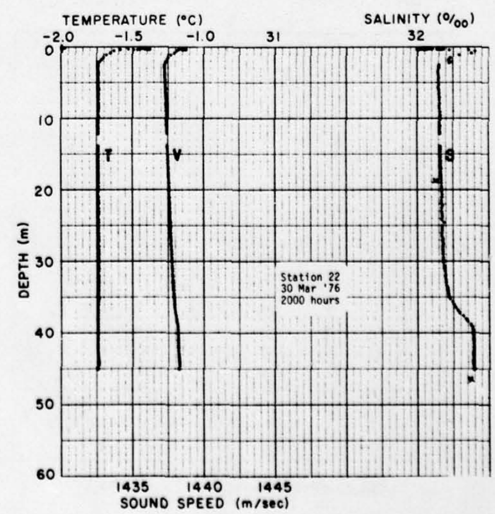

TEMPERATURE (°C)
SALINITY (0/00)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 15
29 Mar '76
2030 hours
1435 1440 1445
SOUND SPEED (m/sec)

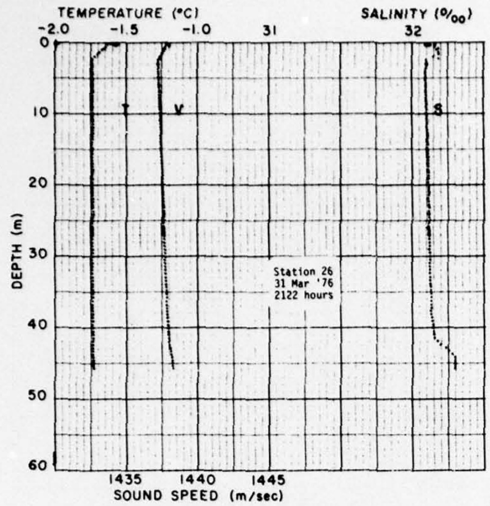

TEMPERATURE (°C)
SALINITY (0/00)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 16
29 Mar '76
2050 hours
1435 1440 1445
SOUND SPEED (m/sec)

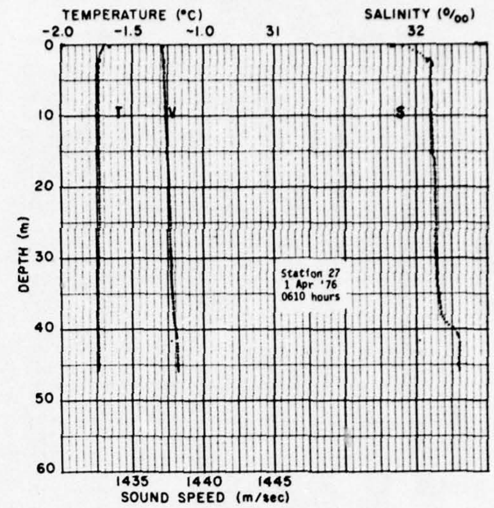

TEMPERATURE (°C)
SALINITY (0/00)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 17
30 Mar '76
0600 hours
1435 1440 1445
SOUND SPEED (m/sec)

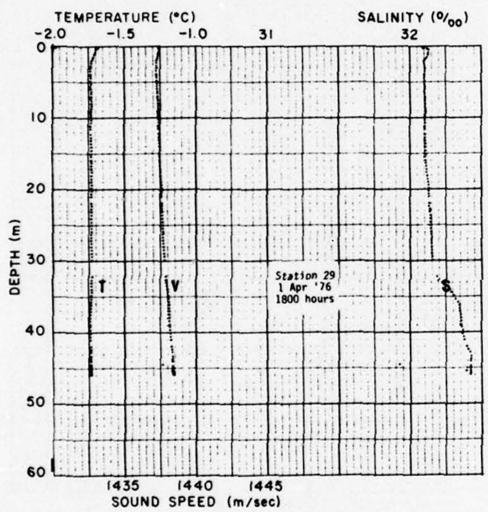

TEMPERATURE (°C)
SALINITY (0/00)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 20
30 Mar '76
0730 hours
1435 1440 1445
SOUND SPEED (m/sec)

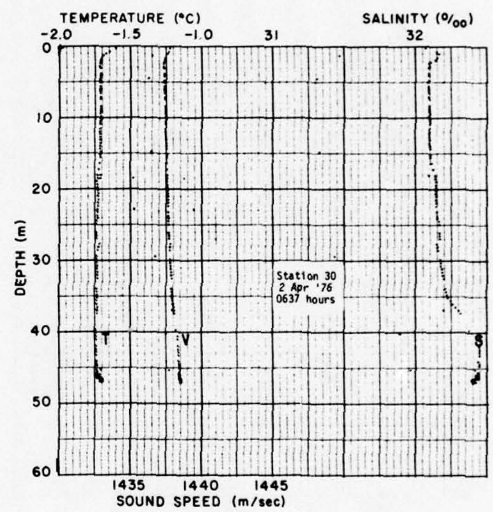

TEMPERATURE (°C)
SALINITY (0/00)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 21
30 Mar '76
0745 hours
1435 1440 1445
SOUND SPEED (m/sec)

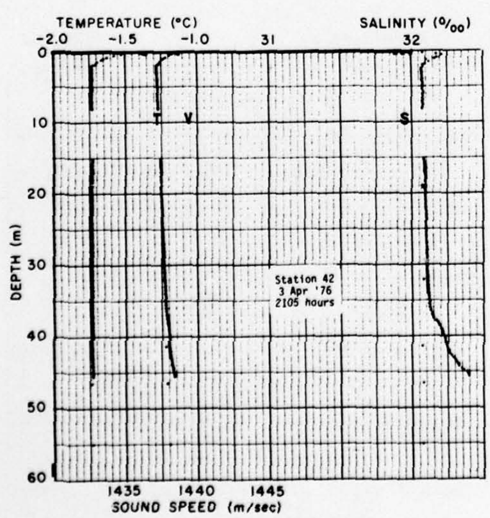

TEMPERATURE (°C)
SALINITY (0/00)
-2.0 -1.5 -1.0 31 32
DEPTH (m)
0 10 20 30 40 50 60
T V S
Station 22
30 Mar '76
2000 hours
1435 1440 1445
SOUND SPEED (m/sec)

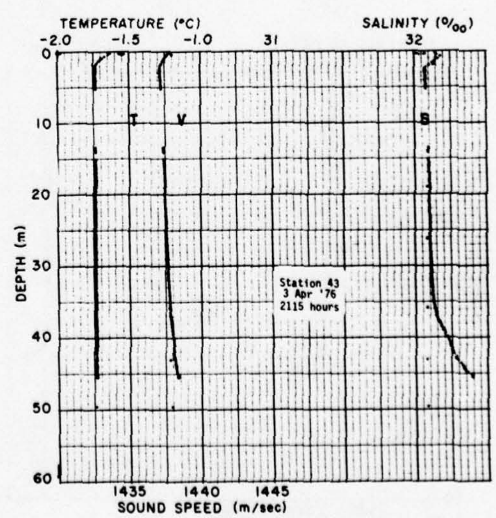

TEMPERATURE (°C)
SALINITY (°/oo)
-2.0 -1.5 -1.0 31 32
0 10 20 30 40 50 60
DEPTH (m)
T V S
Station 26
31 Mar '76
2122 hours
1435 1440 1445
SOUND SPEED (m/sec)

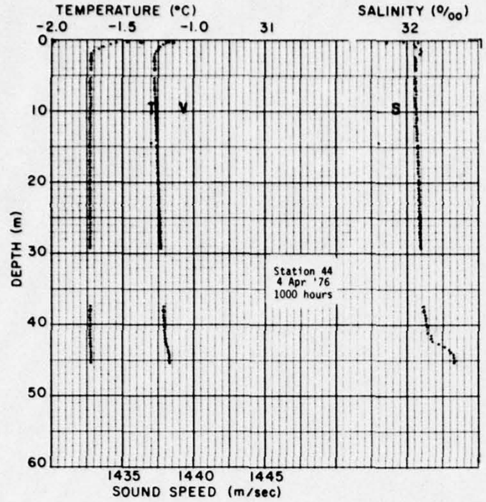

TEMPERATURE (°C)
SALINITY (°/oo)
-2.0 -1.5 -1.0 31 32
0 10 20 30 40 50 60
DEPTH (m)
T V S
Station 27
1 Apr '76
0610 hours
1435 1440 1445
SOUND SPEED (m/sec)

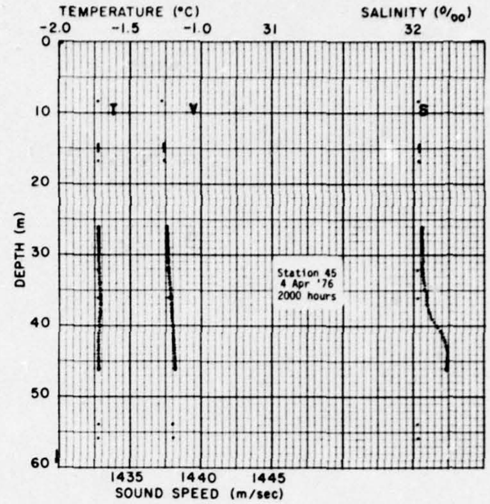

TEMPERATURE (°C)
SALINITY (°/oo)
-2.0 -1.5 -1.0 31 32
0 10 20 30 40 50 60
DEPTH (m)
T V S
Station 29
1 Apr '76
1800 hours
1435 1440 1445
SOUND SPEED (m/sec)

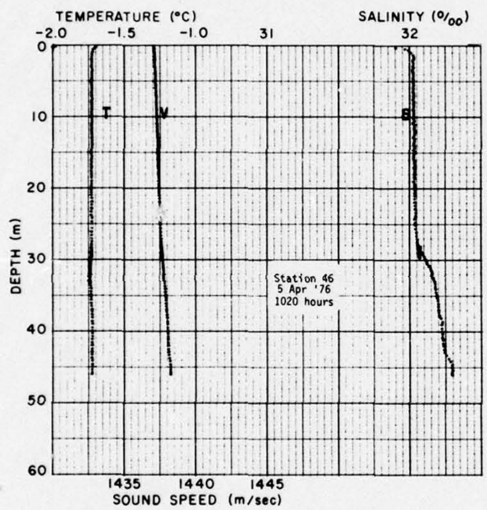

TEMPERATURE (°C)
SALINITY (°/oo)
-2.0 -1.5 -1.0 31 32
0 10 20 30 40 50 60
DEPTH (m)
T V S
Station 30
2 Apr '76
0637 hours
1435 1440 1445
SOUND SPEED (m/sec)

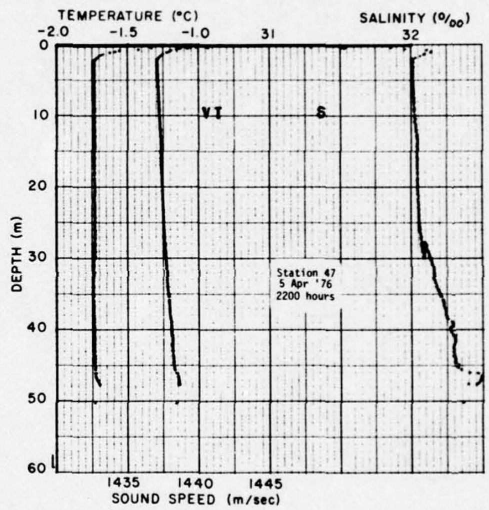

TEMPERATURE (°C)
SALINITY (°/oo)
-2.0 -1.5 -1.0 31 32
0 10 20 30 40 50 60
DEPTH (m)
T V S
Station 42
3 Apr '76
2105 hours
1435 1440 1445
SOUND SPEED (m/sec)

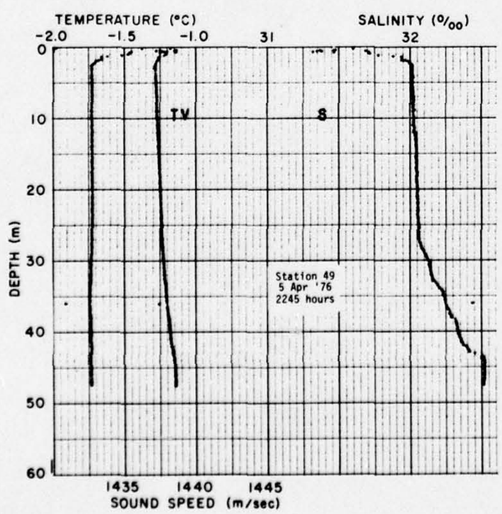

TEMPERATURE (°C)
SALINITY (°/oo)
-2.0 -1.5 -1.0 31 32
0 10 20 30 40 50 60
DEPTH (m)
T V S
Station 43
3 Apr '76
2115 hours
1435 1440 1445
SOUND SPEED (m/sec)

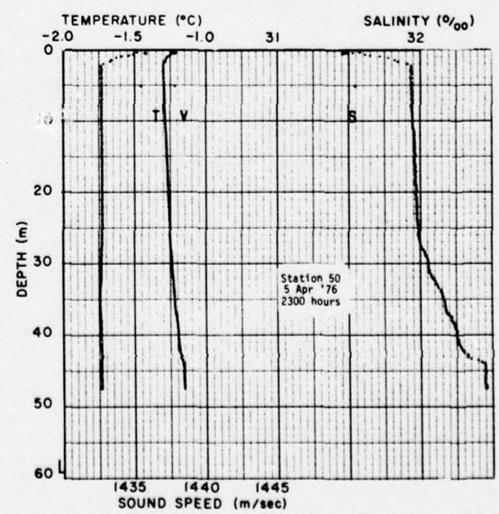

TEMPERATURE (°C)
SALINITY (‰)
-2.0 -1.5 -1.0 31 32
T V S
DEPTH (m)
Station 44
4 Apr '76
1000 hours
1435 1440 1445
SOUND SPEED (m/sec)


TEMPERATURE (°C)
SALINITY (‰)
-2.0 -1.5 -1.0 31 32
T V S
DEPTH (m)
Station 45
4 Apr '76
2000 hours
1435 1440 1445
SOUND SPEED (m/sec)


TEMPERATURE (°C)
SALINITY (‰)
-2.0 -1.5 -1.0 31 32
T V S
DEPTH (m)
Station 46
5 Apr '76
1020 hours
1435 1440 1445
SOUND SPEED (m/sec)


TEMPERATURE (°C)
SALINITY (‰)
-2.0 -1.5 -1.0 31 32
VT S
DEPTH (m)
Station 47
5 Apr '76
2200 hours
1435 1440 1445
SOUND SPEED (m/sec)


TEMPERATURE (°C)
SALINITY (‰)
-2.0 -1.5 -1.0 31 32
TV S
DEPTH (m)
Station 49
5 Apr '76
2245 hours
1435 1440 1445
SOUND SPEED (m/sec)


TEMPERATURE (°C)
SALINITY (‰)
-2.0 -1.5 -1.0 31 32
T V S
DEPTH (m)
Station 50
5 Apr '76
2300 hours
1435 1440 1445
SOUND SPEED (m/sec)

APPENDIX B

CHUKCHI SEA OCEANOGRAPHIC DATA

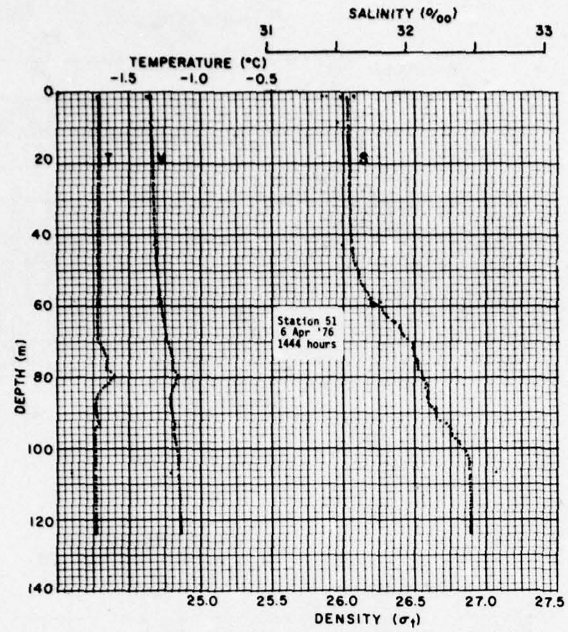
FROM HELICOPTER

APRIL 1976

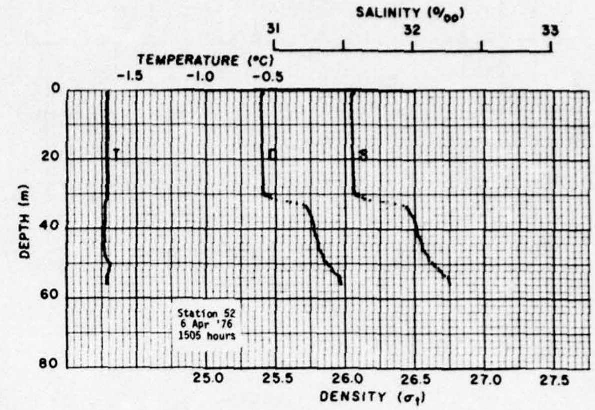
Stations were taken along several lines perpendicular to the coast. Figure 8 shows the locations.

Line	Station	Date	Local Time
Pt. Franklin	51	Apr 6	1444
	52		1505
	53		1526
	54		1544
	55		1602
Wainwright	56		1711
	57		1731
	58		1750
Barrow	59	7	1027
	60		1100
	61		1120
	62		1357
	63		1442
	64		1515
Barrow North	65		1607
	66		1627
	67		1649
	68		1719
Barrow Northeast	69	8	0910
	70		0943
	71		1010
	72		1039
	73		1057
	74		1116
Midway	75		1357
	76		1415
	77		1432
	78		1451
	79		1512
Barrow East	80	9	0906
	81		0942
	82		1010
	83		1034
	84		1104

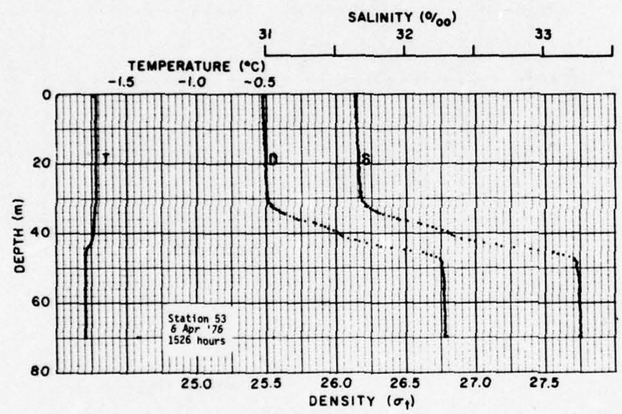
Line	Station	Date	Local Time
Barrow Northeast	85	Apr 9	1355
	86		1426
	87		1452
	88	11	1100
	89		1140
	90		1220
	91		1315
Pt. Franklin	92		p.m.
	93		p.m.
	94		p.m.
	95		p.m.



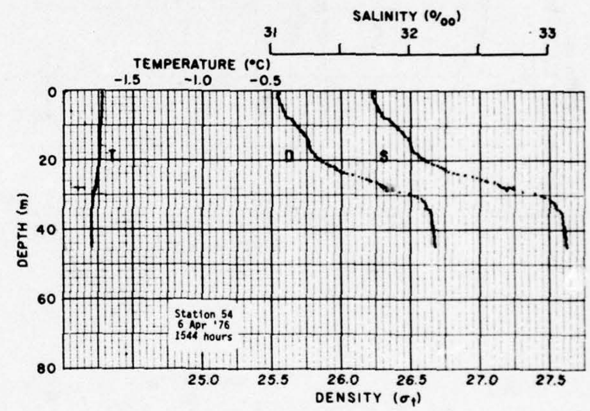
SALINITY (°/oo)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
100
120
140
T
M
S
Station 51
6 Apr '76
1444 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σt)



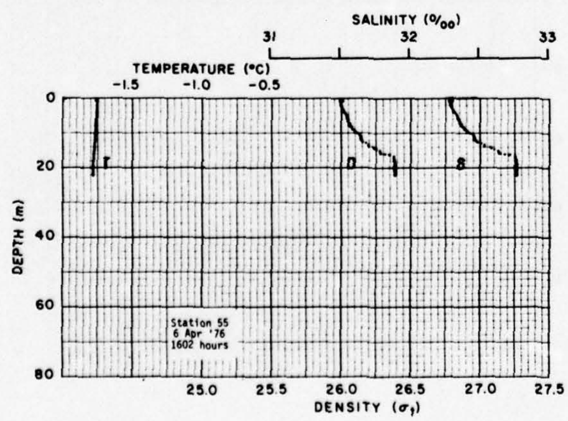
SALINITY (°/oo)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
T
D
S
Station 52
6 Apr '76
1505 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σt)



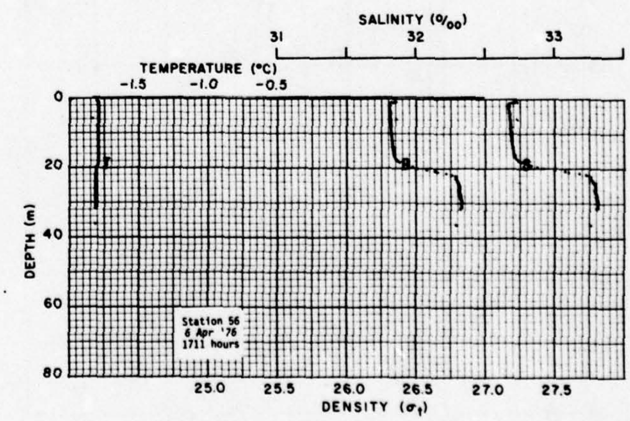
SALINITY (°/oo)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
T
D
S
Station 53
6 Apr '76
1526 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σt)



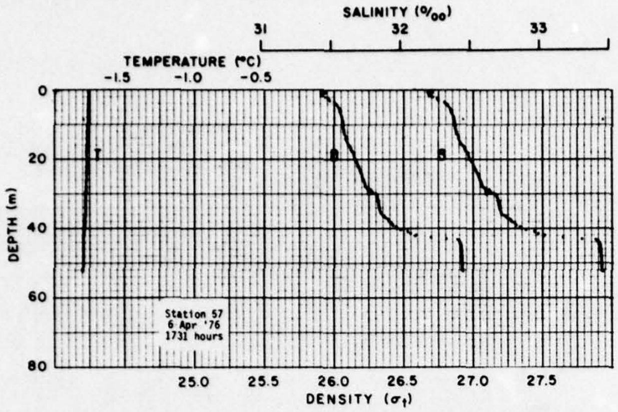
SALINITY (°/oo)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
T
D
S
Station 54
6 Apr '76
1544 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σt)

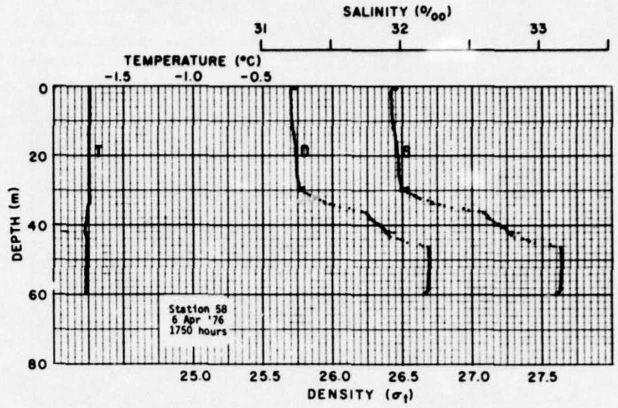


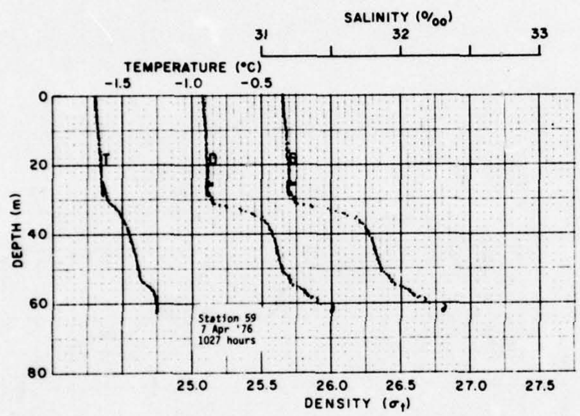
SALINITY (°/oo)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
T
D
S
Station 55
6 Apr '76
1602 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σt)

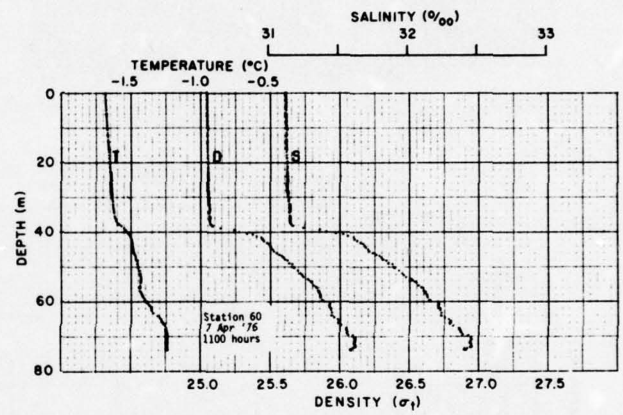


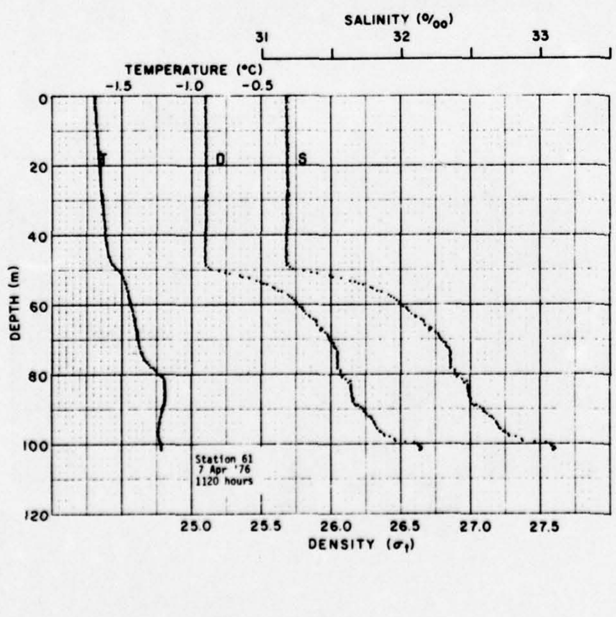
SALINITY (°/oo)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
T
D
S
Station 56
6 Apr '76
1711 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σt)

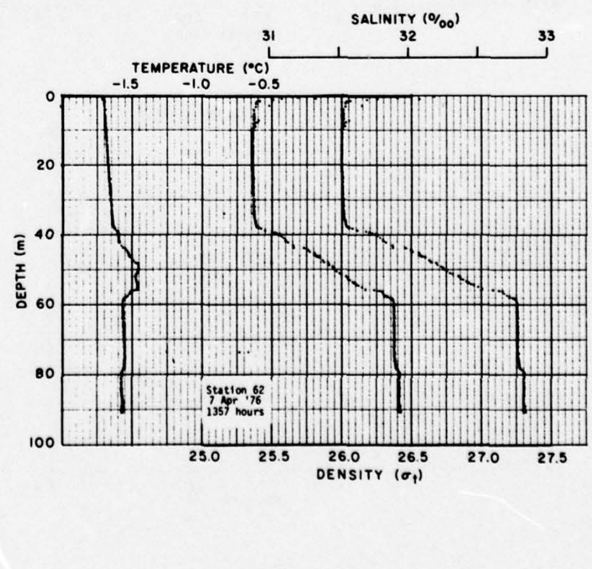

SALINITY (‰)
31 32 33
TEMPERATURE (°C)
-1.5 -1.0 -0.5
DEPTH (m)
0 20 40 60 80
T D S
Station 57
6 Apr '76
1731 hours
25.0 25.5 26.0 26.5 27.0 27.5
DENSITY (σ_t)

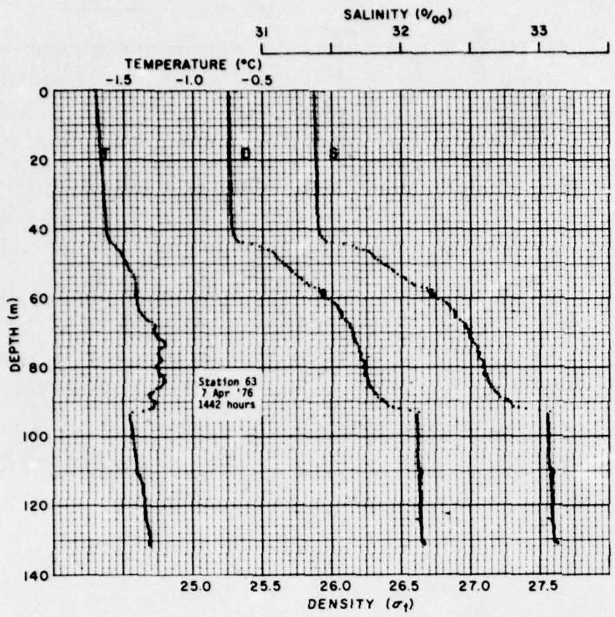

SALINITY (‰)
31 32 33
TEMPERATURE (°C)
-1.5 -1.0 -0.5
DEPTH (m)
0 20 40 60 80
T D S
Station 58
6 Apr '76
1750 hours
25.0 25.5 26.0 26.5 27.0 27.5
DENSITY (σ_t)

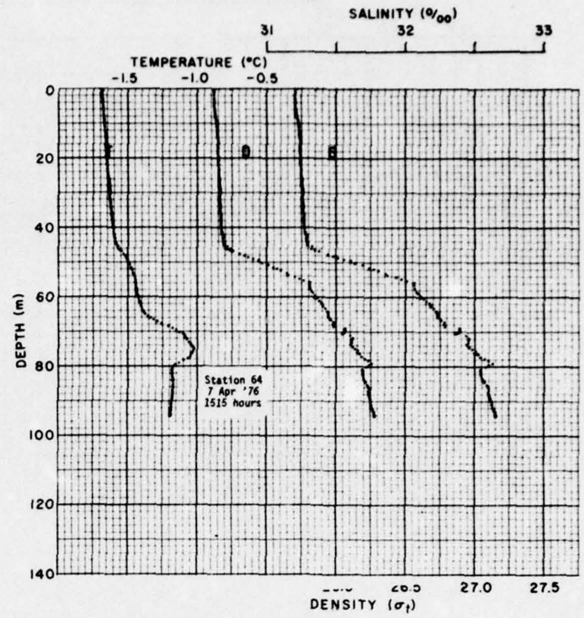

SALINITY (‰)
31 32 33
TEMPERATURE (°C)
-1.5 -1.0 -0.5
DEPTH (m)
0 20 40 60 80
T D S
Station 59
7 Apr '76
1027 hours
25.0 25.5 26.0 26.5 27.0 27.5
DENSITY (σ_t)

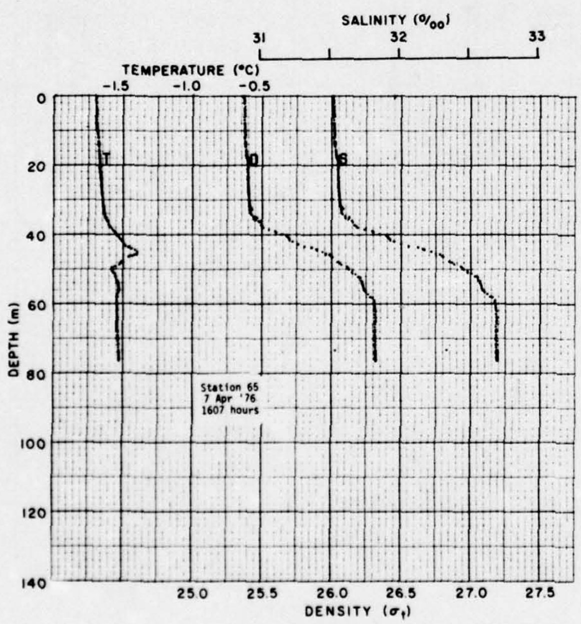

SALINITY (‰)
31 32 33
TEMPERATURE (°C)
-1.5 -1.0 -0.5
DEPTH (m)
0 20 40 60 80
T D S
Station 60
7 Apr '76
1100 hours
25.0 25.5 26.0 26.5 27.0 27.5
DENSITY (σ_t)

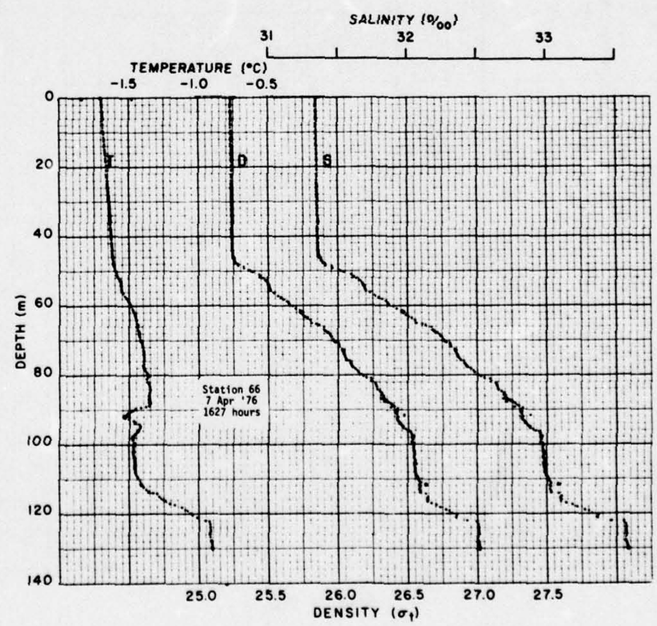

SALINITY (‰)
31 32 33
TEMPERATURE (°C)
-1.5 -1.0 -0.5
DEPTH (m)
0 20 40 60 80 100 120
T D S
Station 61
7 Apr '76
1120 hours
25.0 25.5 26.0 26.5 27.0 27.5
DENSITY (σ_t)

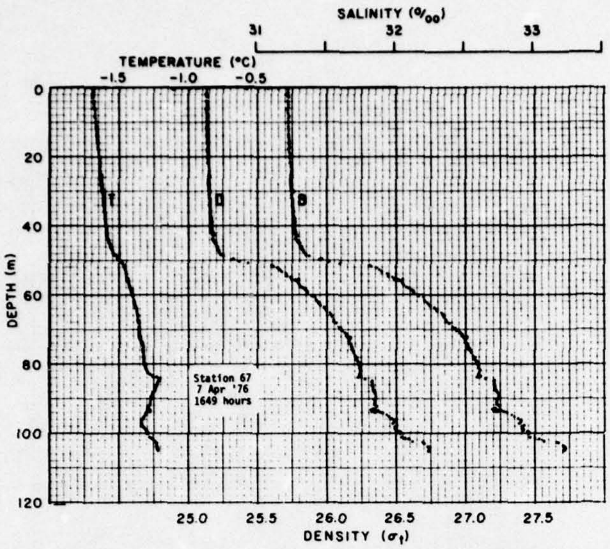

SALINITY (‰)
31 32 33
TEMPERATURE (°C)
-1.5 -1.0 -0.5
DEPTH (m)
0 20 40 60 80 100
Station 62
7 Apr '76
1357 hours
25.0 25.5 26.0 26.5 27.0 27.5
DENSITY (σ_t)

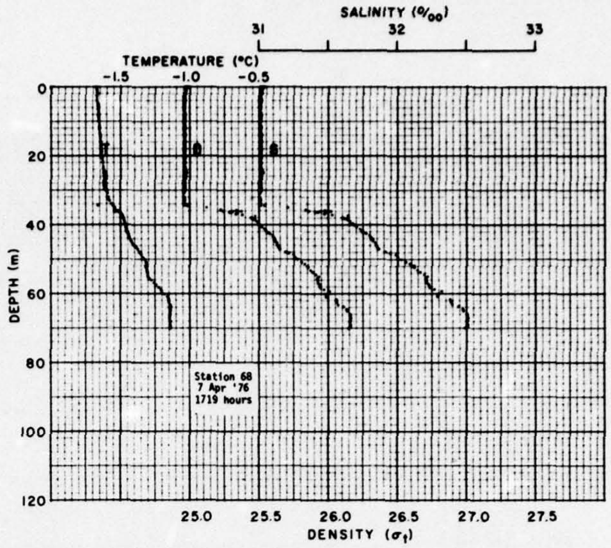

SALINITY (0/00)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
T
D
S
Station 63
7 Apr '76
1442 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

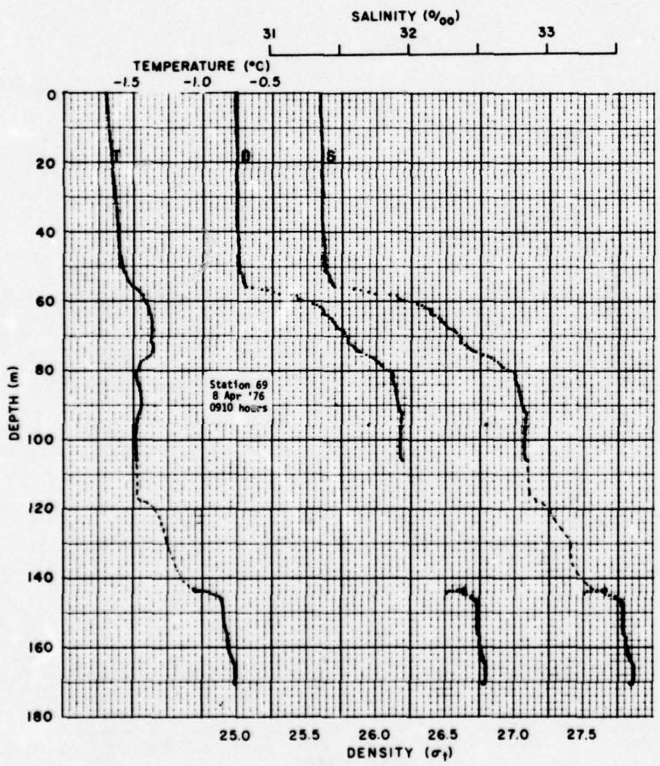

SALINITY (0/00)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
T
D
S
Station 64
7 Apr '76
1515 hours
27.0
27.5
DENSITY (σ_t)

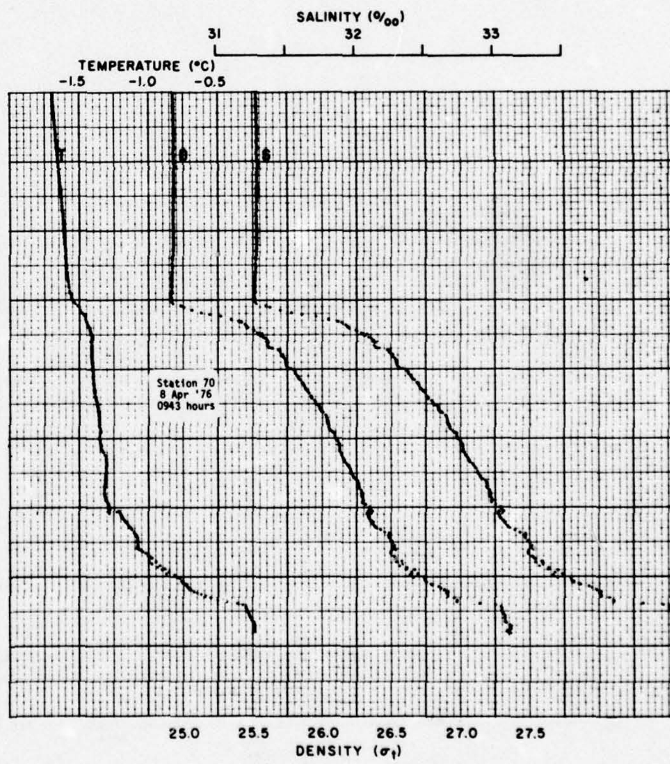

SALINITY (0/00)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
T
D
S
Station 65
7 Apr '76
1607 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

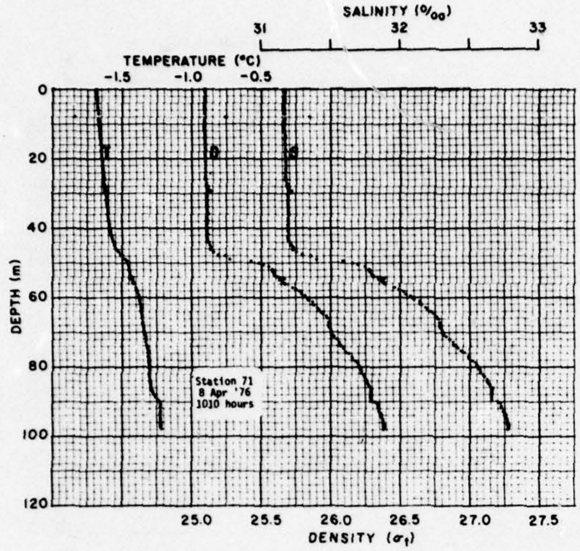

SALINITY (0/00)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
T
D
S
Station 66
7 Apr '76
1627 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

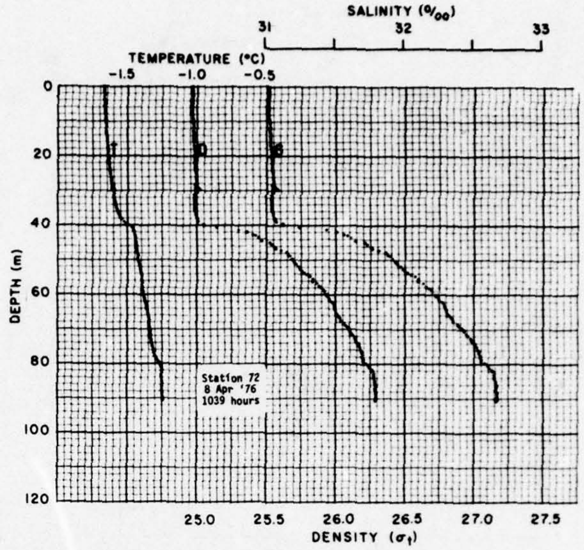

SALINITY (‰)
TEMPERATURE (°C)
DEPTH (m)
DENSITY (σ_t)
Station 67
7 Apr '76
1649 hours

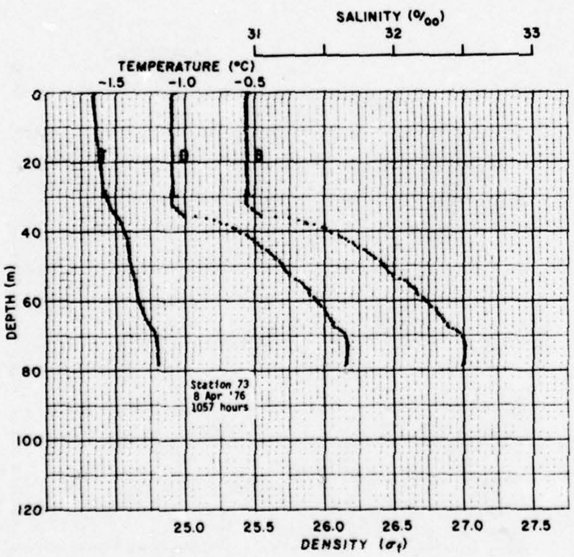

SALINITY (‰)
TEMPERATURE (°C)
DEPTH (m)
DENSITY (σ_t)
Station 68
7 Apr '76
1719 hours

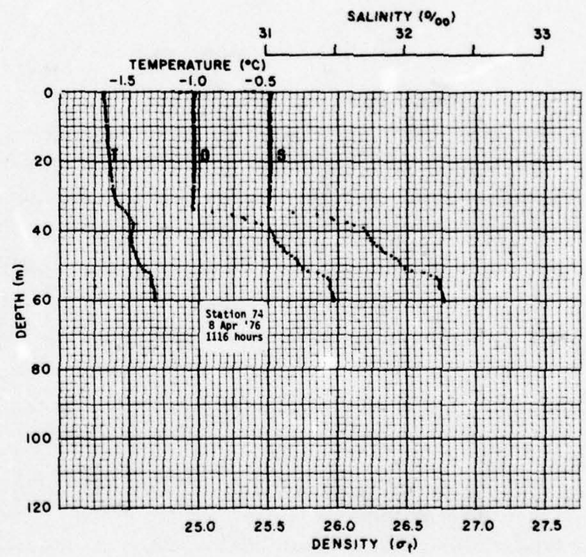

SALINITY (‰)
TEMPERATURE (°C)
DEPTH (m)
DENSITY (σ_t)
Station 69
8 Apr '76
0910 hours

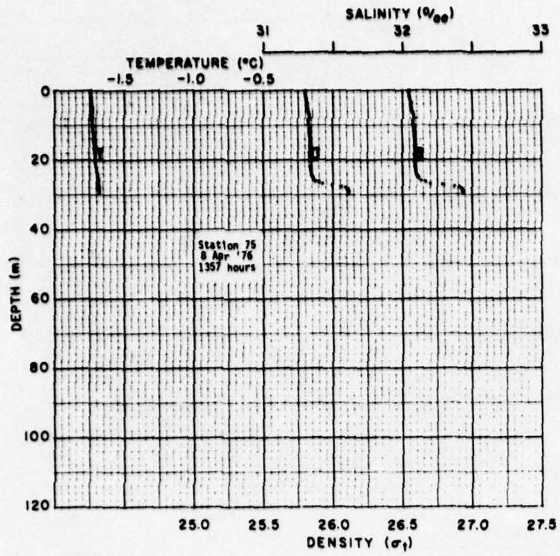

SALINITY (‰)
TEMPERATURE (°C)
DENSITY (σ_t)
Station 70
8 Apr '76
0943 hours

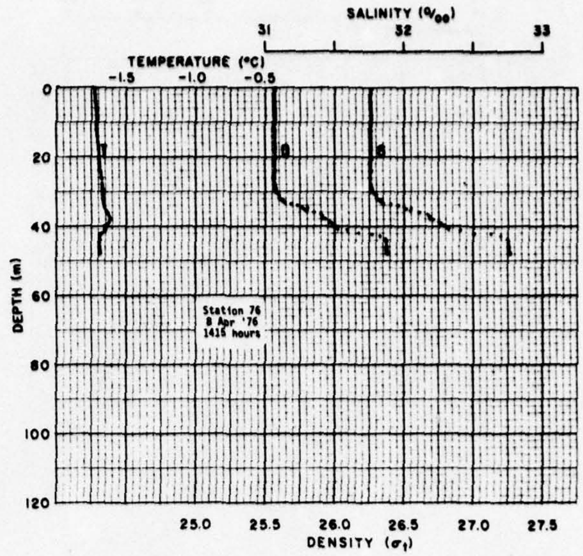

SALINITY (‰)
31 32 33
TEMPERATURE (°C)
-1.5 -1.0 -0.5
DEPTH (m)
0 20 40 60 80 100 120
T
D
S
Station 71
8 Apr '76
1010 hours
25.0 25.5 26.0 26.5 27.0 27.5
DENSITY (σ_t)

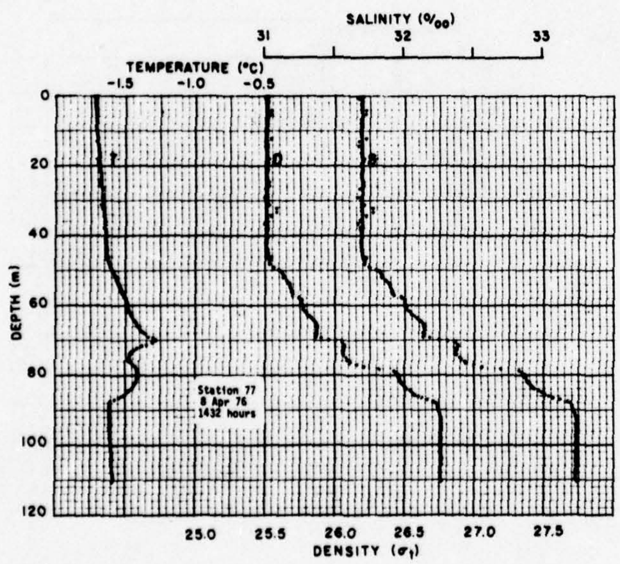

SALINITY (‰)
31 32 33
TEMPERATURE (°C)
-1.5 -1.0 -0.5
DEPTH (m)
0 20 40 60 80 100 120
T
D
S
Station 72
8 Apr '76
1039 hours
25.0 25.5 26.0 26.5 27.0 27.5
DENSITY (σ_t)

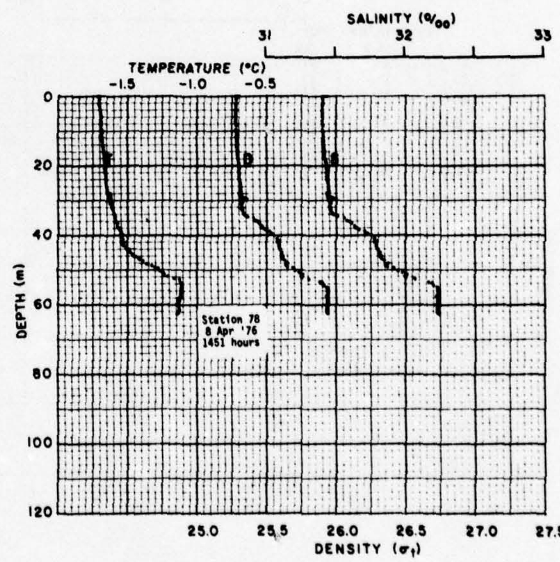

SALINITY (‰)
31 32 33
TEMPERATURE (°C)
-1.5 -1.0 -0.5
DEPTH (m)
0 20 40 60 80 100 120
T
D
S
Station 73
8 Apr '76
1057 hours
25.0 25.5 26.0 26.5 27.0 27.5
DENSITY (σ_t)

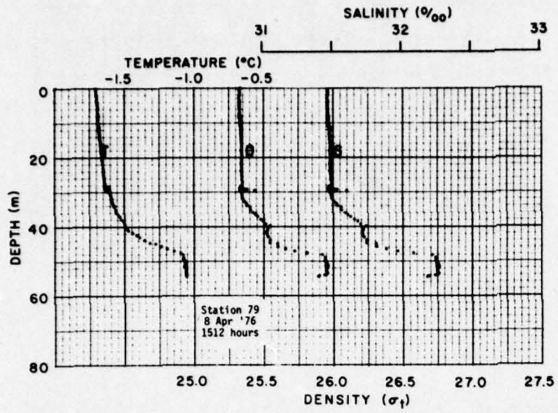

SALINITY (‰)
31 32 33
TEMPERATURE (°C)
-1.5 -1.0 -0.5
DEPTH (m)
0 20 40 60 80 100 120
T
D
S
Station 74
8 Apr '76
1116 hours
25.0 25.5 26.0 26.5 27.0 27.5
DENSITY (σ_t)

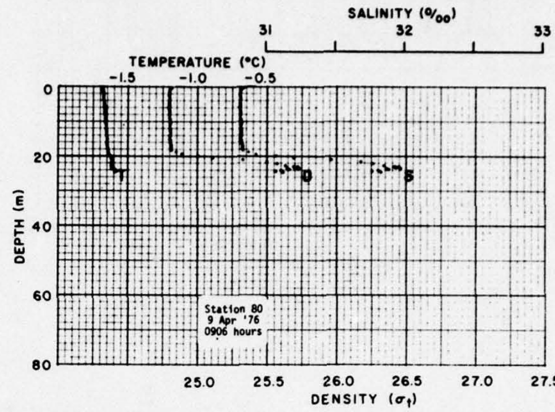

SALINITY (‰)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
Station 75
8 Apr '76
1357 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

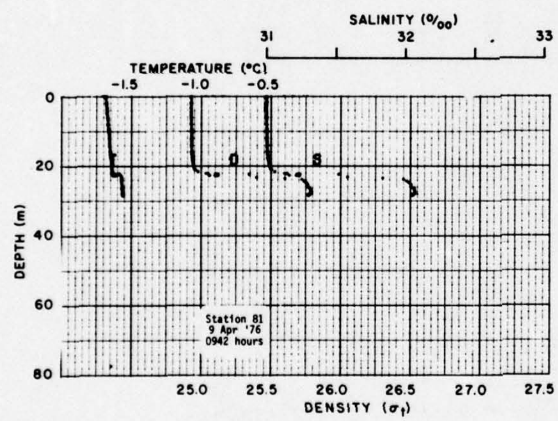

SALINITY (‰)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
Station 76
8 Apr '76
1416 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

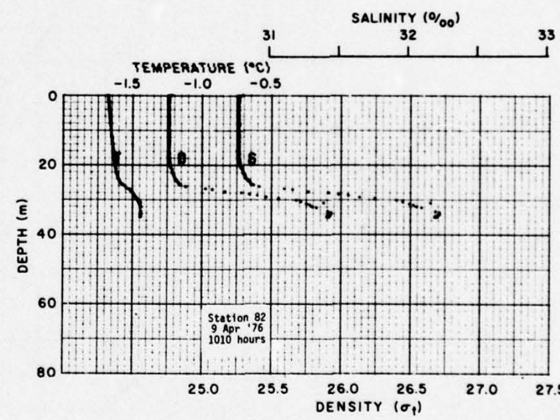

SALINITY (‰)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
Station 77
8 Apr 76
1432 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

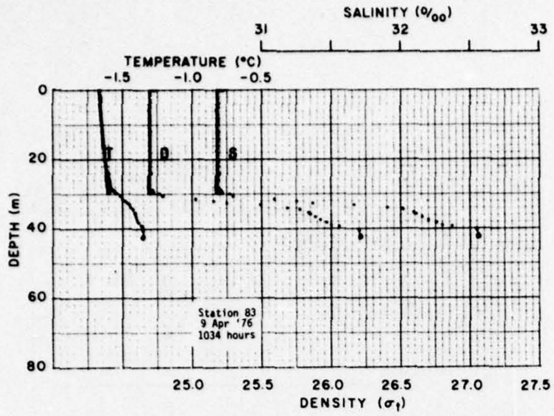

SALINITY (‰)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
Station 78
8 Apr '76
1451 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

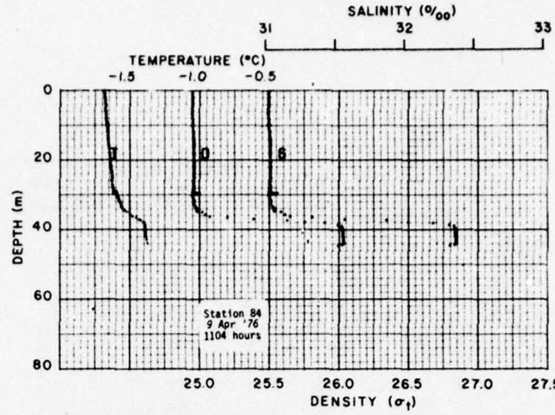

SALINITY (0/00)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σt)
Station 79
8 Apr '76
1512 hours

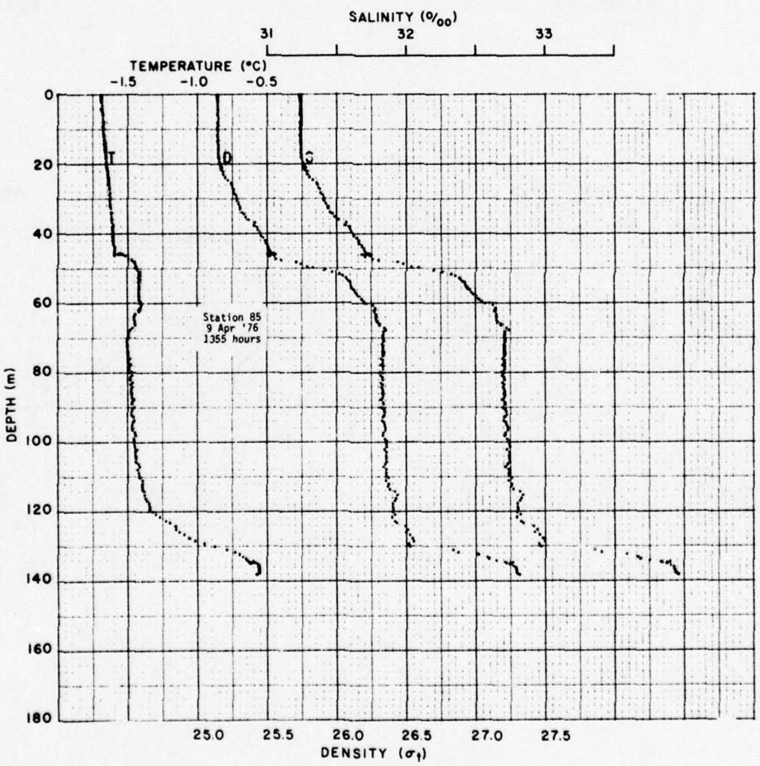

SALINITY (0/00)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σt)
Station 80
9 Apr '76
0906 hours

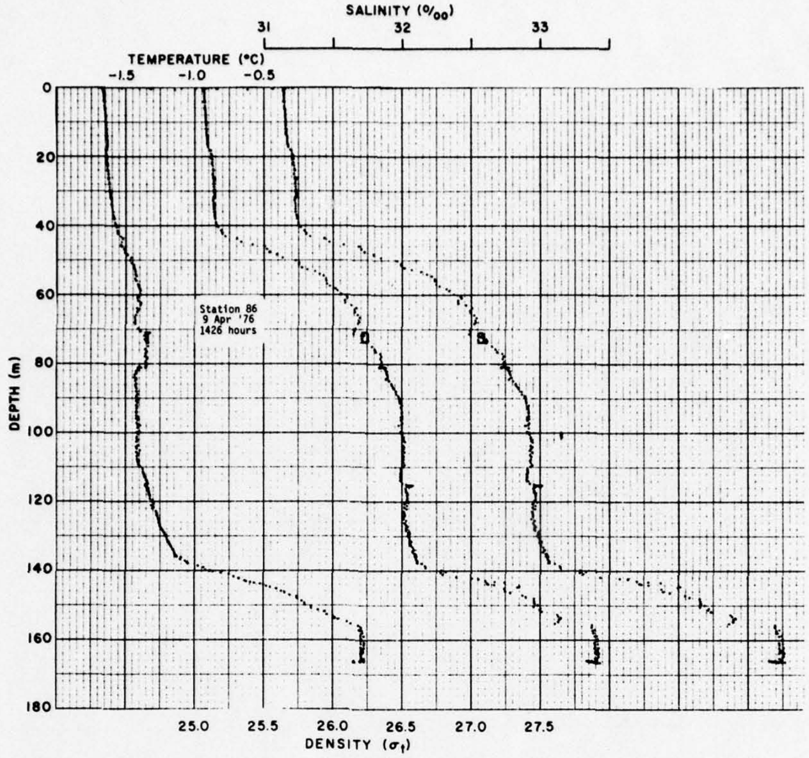

SALINITY (0/00)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σt)
Station 81
9 Apr '76
0942 hours

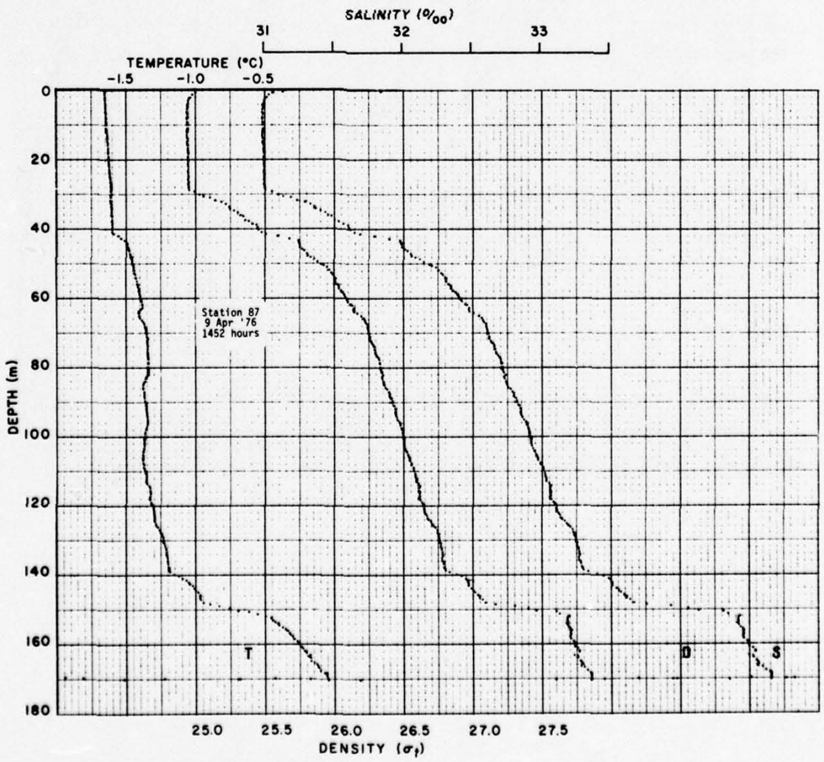

SALINITY (0/00)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σt)
Station 82
9 Apr '76
1010 hours

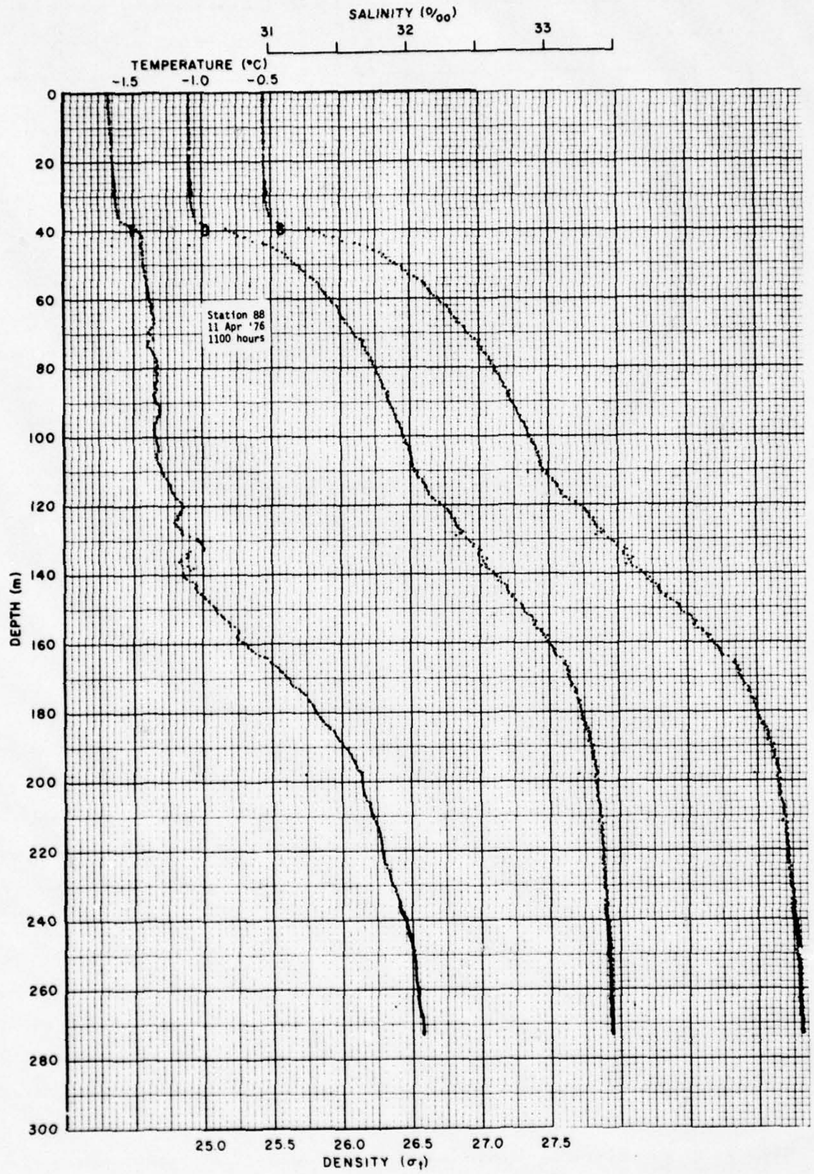

SALINITY (‰)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
0
20
40
60
80
DEPTH (m)
T
D
S
Station 83
9 Apr '76
1034 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

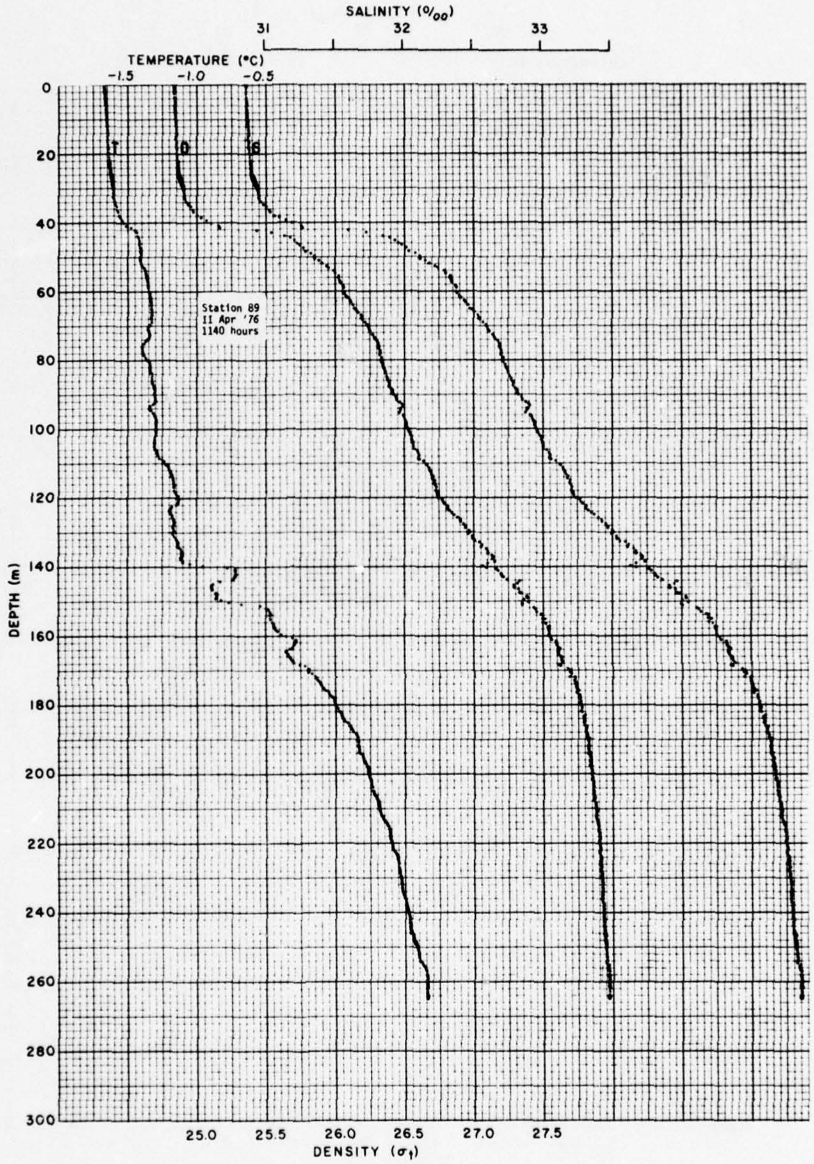

SALINITY (‰)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
0
20
40
60
80
DEPTH (m)
T
D
S
Station 84
9 Apr '76
1104 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)


SALINITY (‰)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
0
20
40
60
80
100
120
140
160
180
DEPTH (m)
T
D
S
Station 85
9 Apr '76
1355 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

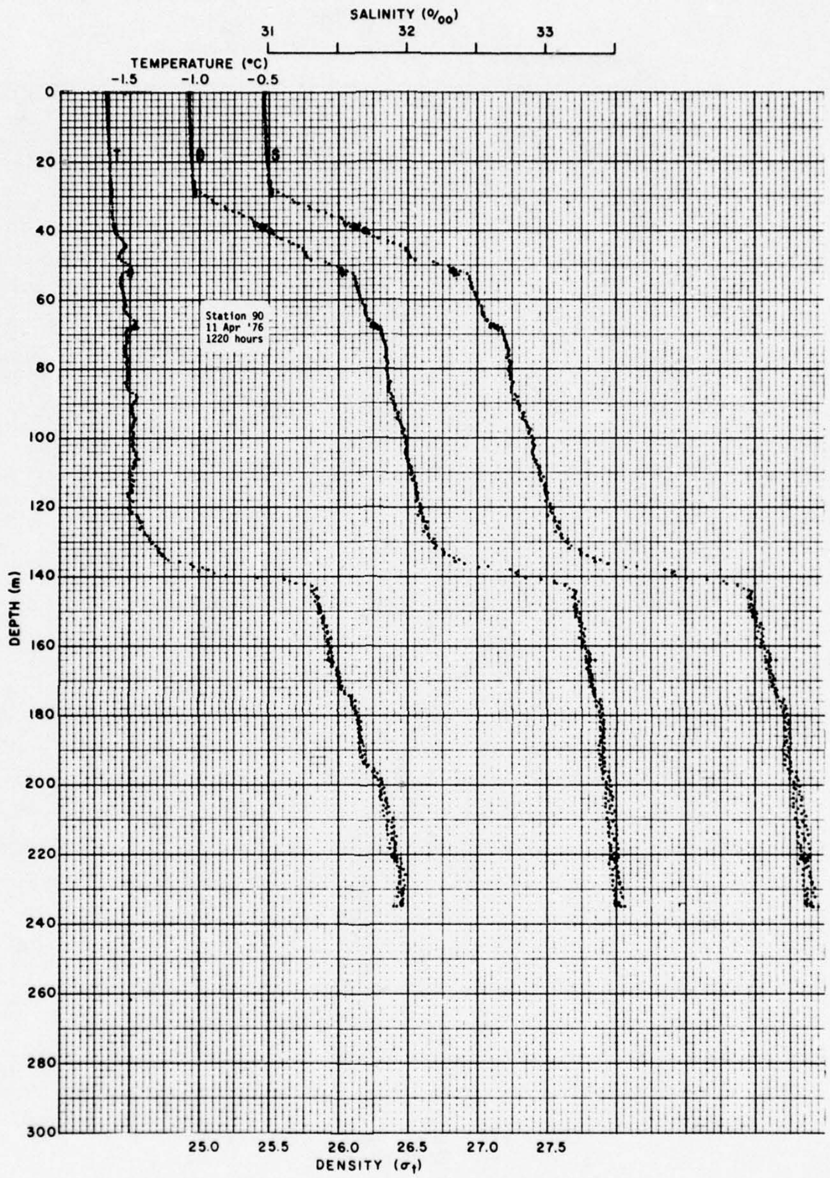

SALINITY (‰)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
Station 86
9 Apr '76
1426 hours
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
T
D
S
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

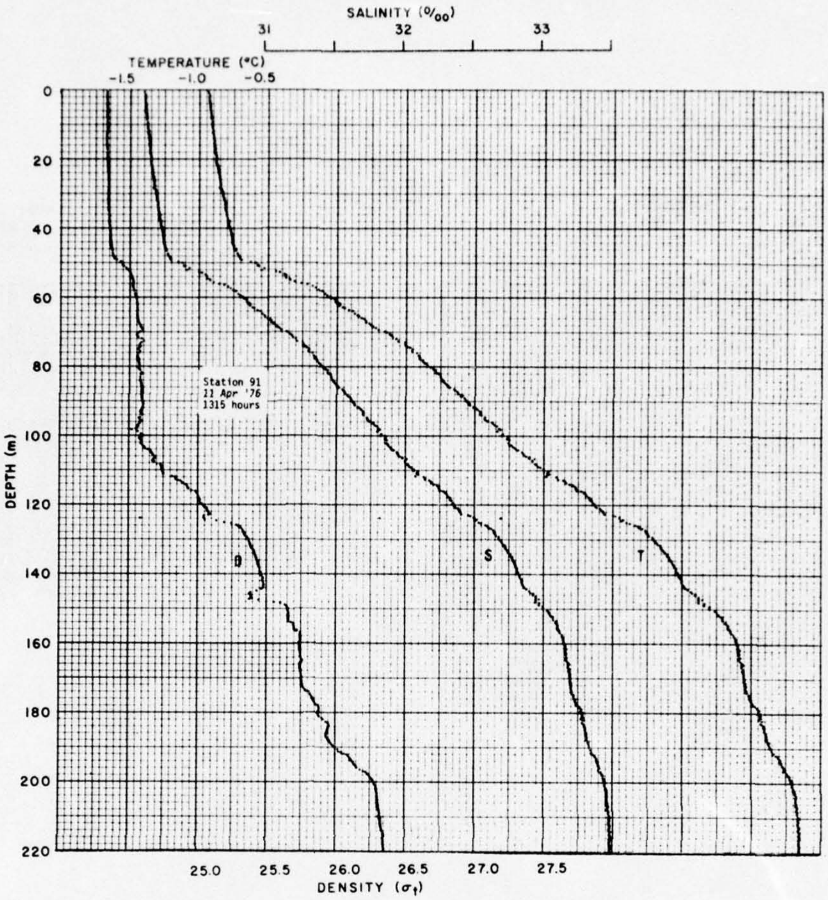

SALINITY (‰)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
Station 87
9 Apr '76
1452 hours
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
T
D
S
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

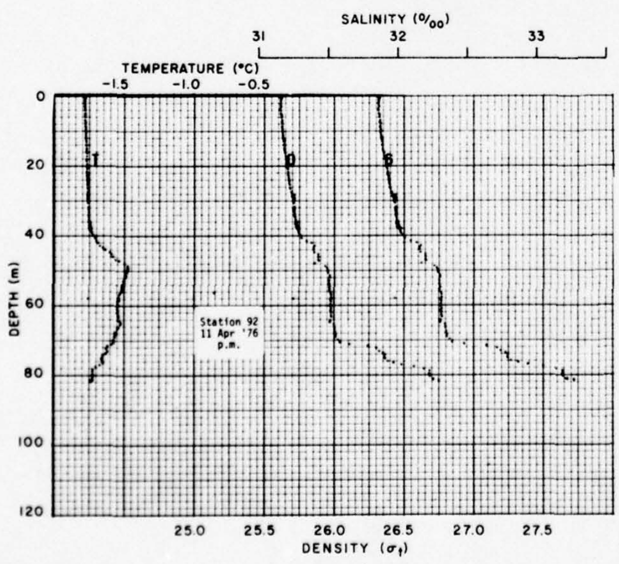

SALINITY (0/00)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
Station 88
11 Apr '76
1100 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

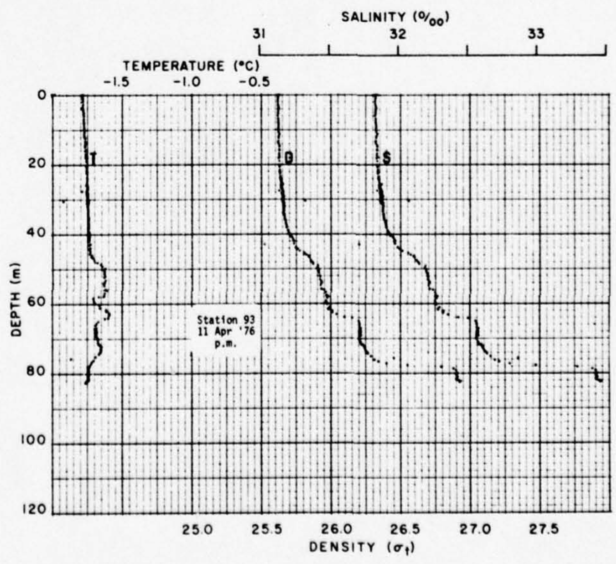


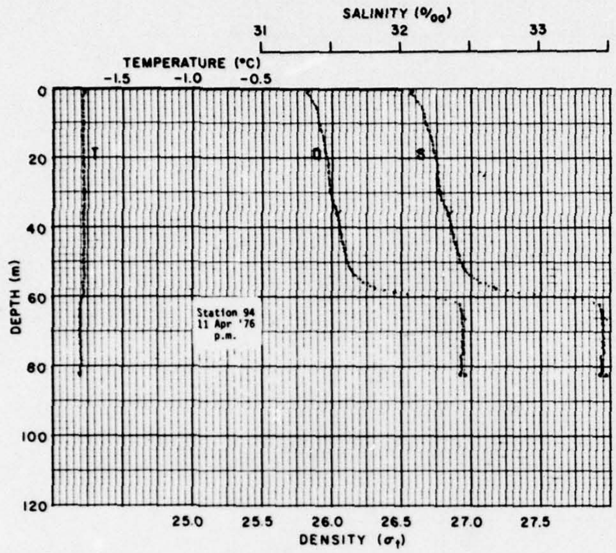
SALINITY (°/oo)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
T
D
S
Station 89
11 Apr '76
1140 hours
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

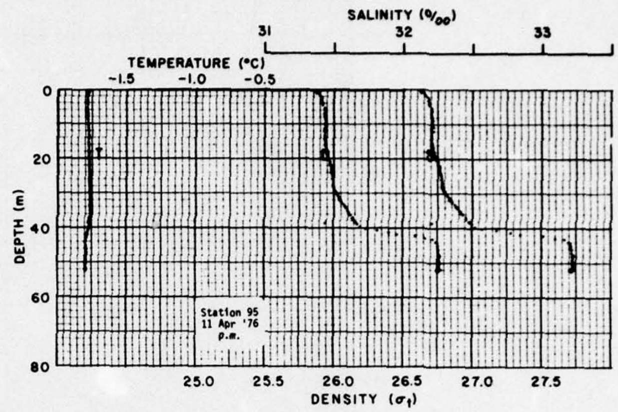

SALINITY (0/00)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
Station 90
11 Apr '76
1220 hours
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)


SALINITY (°/oo)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
200
220
Station 91
11 Apr '76
1315 hours
D
S
T
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)


SALINITY (°/oo)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
100
120
T
D
S
Station 92
11 Apr '76
p.m.
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)


SALINITY (°/oo)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
100
120
T
D
S
Station 93
11 Apr '76
p.m.
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)


SALINITY (‰)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
100
120
T
D
S
Station 94
11 Apr '76
p.m.
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)


SALINITY (‰)
31
32
33
TEMPERATURE (°C)
-1.5
-1.0
-0.5
DEPTH (m)
0
20
40
60
80
T
D
S
Station 95
11 Apr '76
p.m.
25.0
25.5
26.0
26.5
27.0
27.5
DENSITY (σ_t)

APPENDIX C

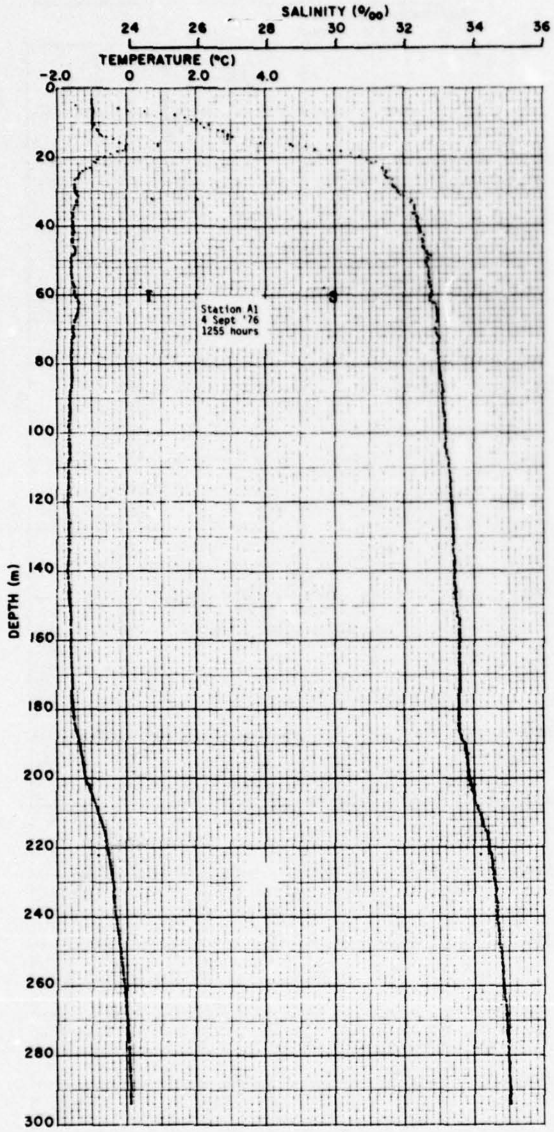
CHUKCHI SEA OCEANOGRAPHIC DATA

FROM COAST GUARD HELICOPTER

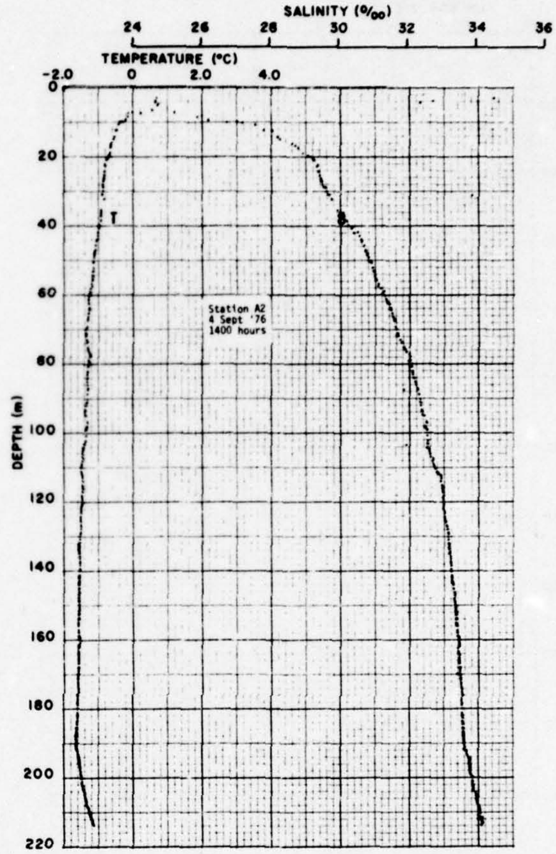
SEPTEMBER 1976

Stations were taken along several lines perpendicular to the coast. Figure 20 shows the location.

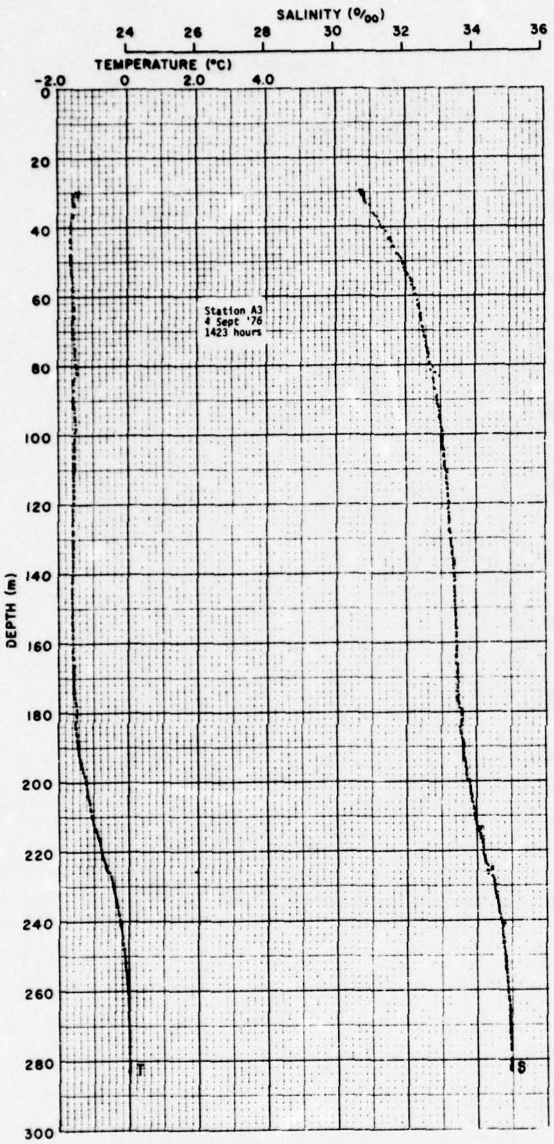
Line	Station	Date	Local Time
Barrow Northeast	A1	Sept 4	1255
	A2		1400
	A3		1423
	A4	5	1635
	A5		1700
	A6		1722
	A7		1739
Barrow North	B1	19	1430
	B2		1409
	B3		1300
	B4		1216
	B5		1207
	B6		1330
	B7		1346
	B8	20	1900
Barrow	C1	19	1050
	C2		1100
	C3		1113
	C4		1122
	C5		1132
	C6	20	1946
	C7		1928

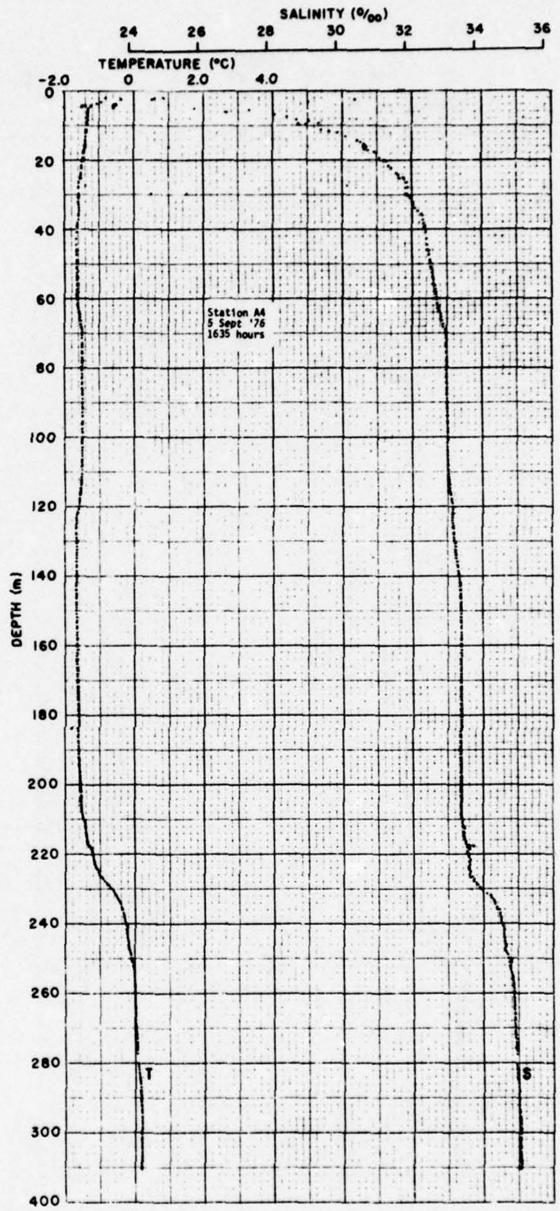


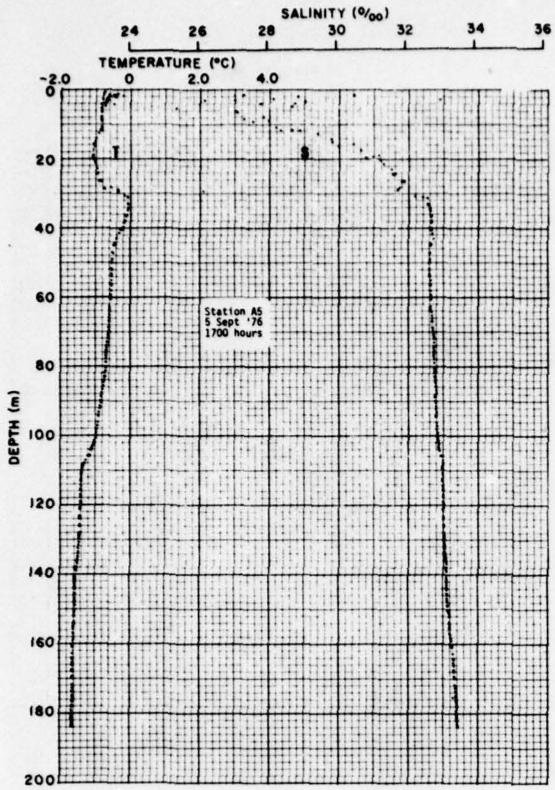
SALINITY (‰)
24
26
28
30
32
34
36
TEMPERATURE (°C)
-2.0
0
2.0
4.0
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
T
S
Station A1
4 Sept '76
1255 hours

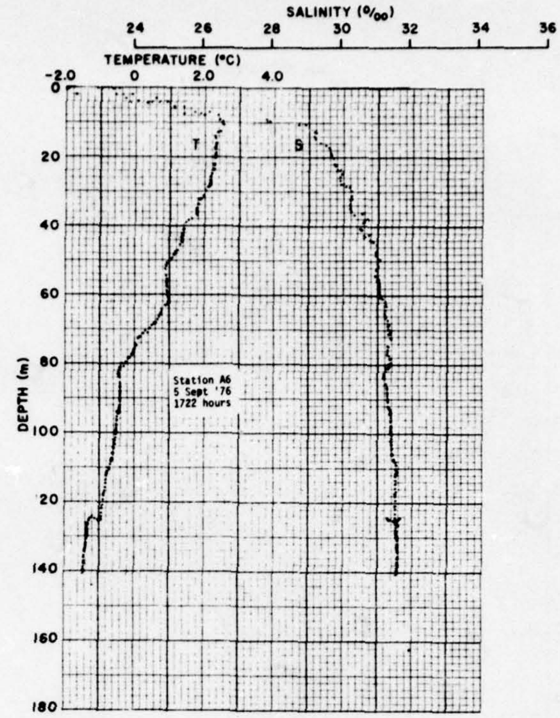


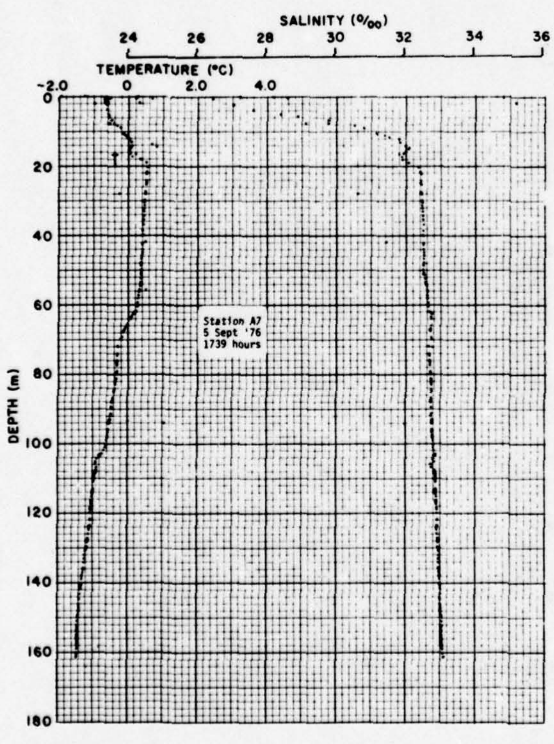
SALINITY (‰)
24
26
28
30
32
34
36
TEMPERATURE (°C)
-2.0
0
2.0
4.0
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
200
220
T
S
Station A2
4 Sept '76
1400 hours

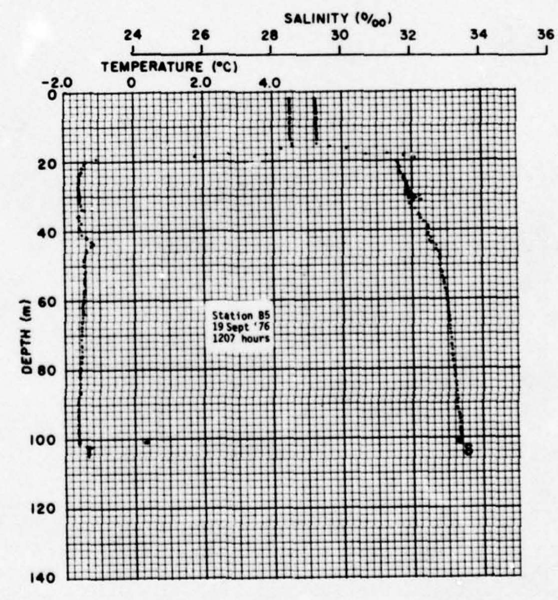

SALINITY (‰)
24 26 28 30 32 34 36
TEMPERATURE (°C)
-2.0 0 2.0 4.0
DEPTH (m)
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
Station A3
4 Sept '76
1423 hours
T
S

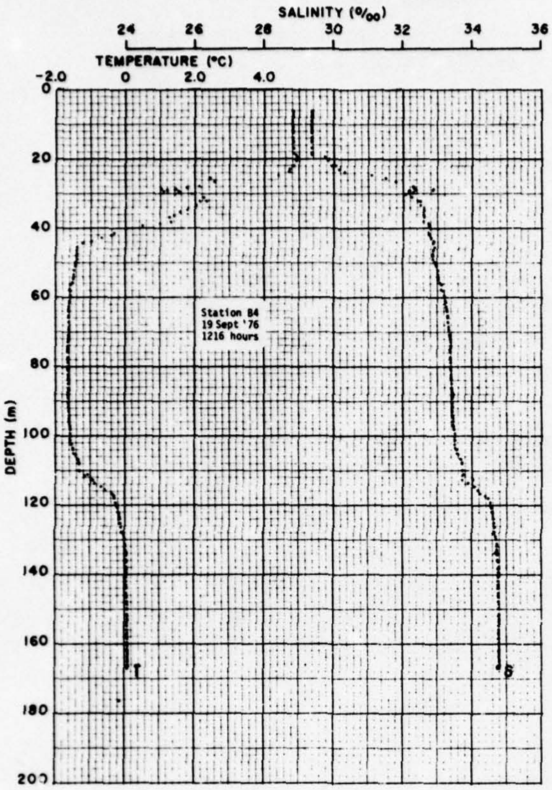

SALINITY (‰)
24 26 28 30 32 34 36
TEMPERATURE (°C)
-2.0 0 2.0 4.0
DEPTH (m)
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 400
Station A4
5 Sept '76
1635 hours
T
S

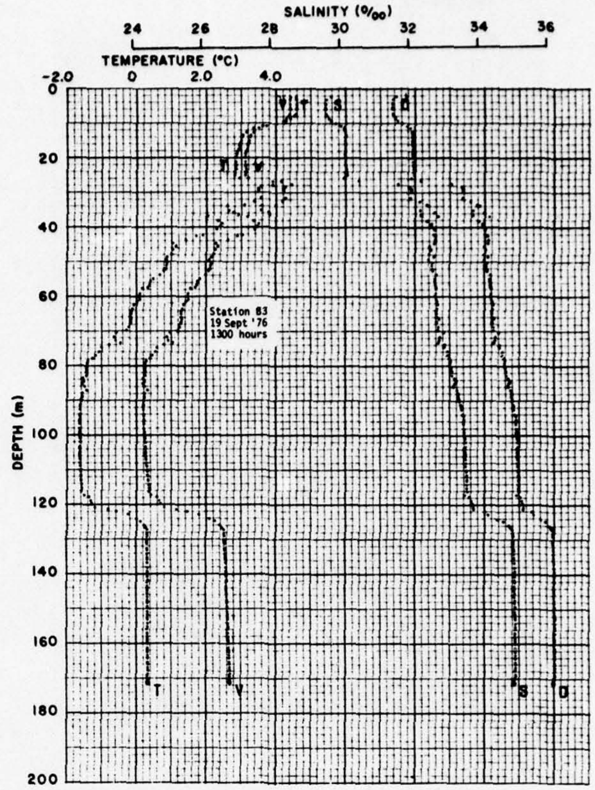

SALINITY (0/00)
TEMPERATURE (°C)
DEPTH (m)
T
S
Station A5
5 Sept '76
1700 hours

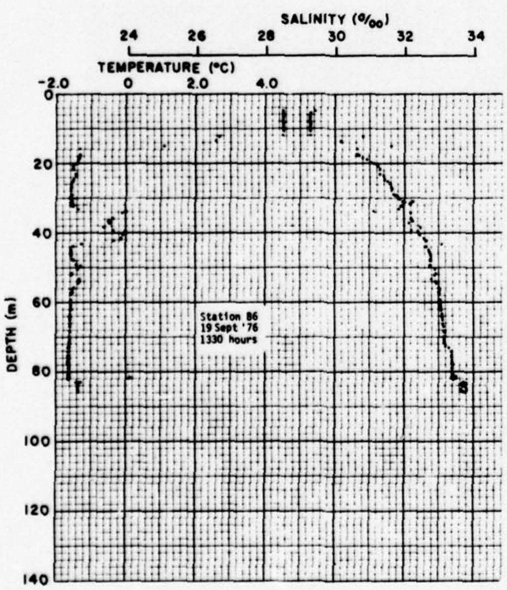

SALINITY (0/00)
TEMPERATURE (°C)
DEPTH (m)
T
S
Station A6
5 Sept '76
1722 hours

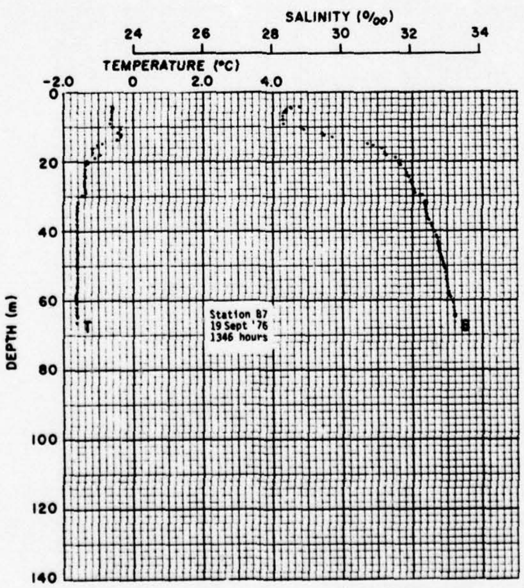

SALINITY (0/00)
TEMPERATURE (°C)
DEPTH (m)
T
Station A7
5 Sept '76
1739 hours

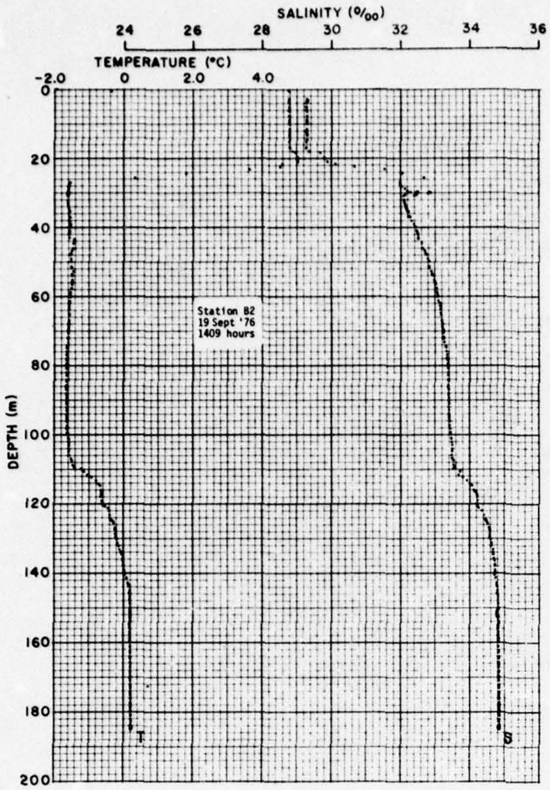

SALINITY (0/00)
TEMPERATURE (°C)
DEPTH (m)
T
S
Station B5
19 Sept '76
1207 hours

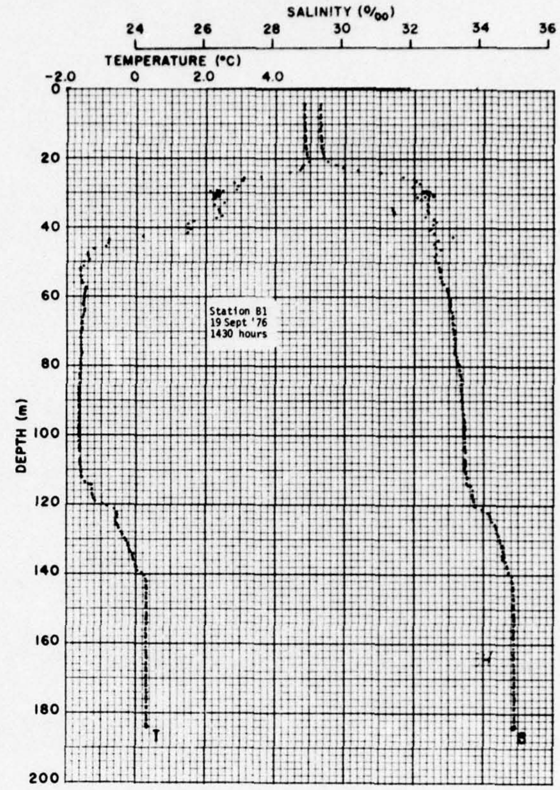

SALINITY (0/00)
24 26 28 30 32 34 36
TEMPERATURE (°C)
-2.0 0 2.0 4.0
DEPTH (m)
0 20 40 60 80 100 120 140 160 180 200
Station 84
19 Sept '76
1216 hours
T
S

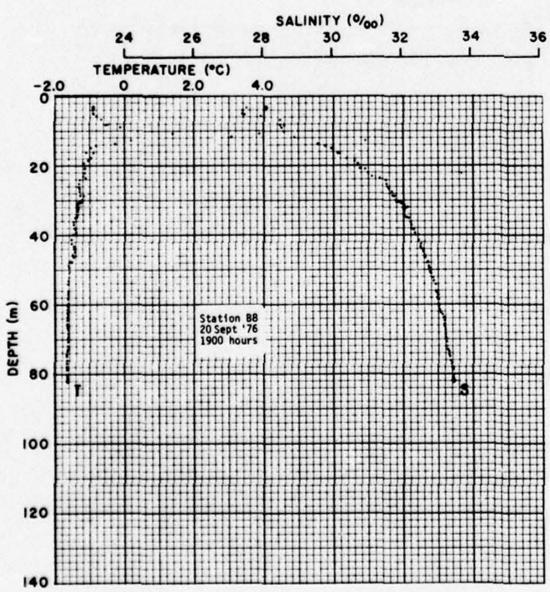

SALINITY (0/00)
24 26 28 30 32 34 36
TEMPERATURE (°C)
-2.0 0 2.0 4.0
DEPTH (m)
0 20 40 60 80 100 120 140 160 180 200
Station 83
19 Sept '76
1300 hours
T
V
S
D

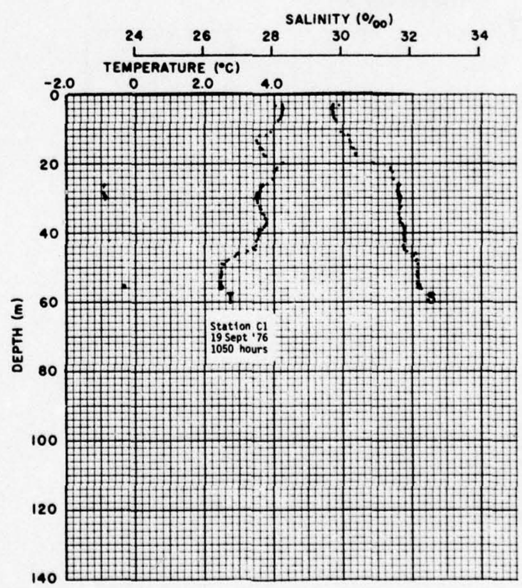

SALINITY (0/00)
24 26 28 30 32 34
TEMPERATURE (°C)
-2.0 0 2.0 4.0
DEPTH (m)
0 20 40 60 80 100 120 140
Station 86
19 Sept '76
1330 hours
T
S

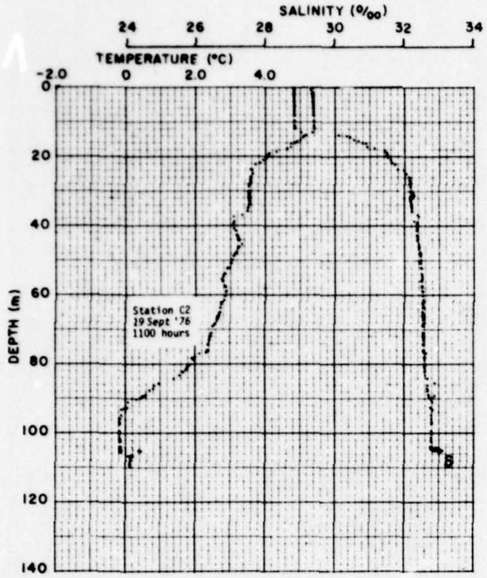

SALINITY (0/00)
24 26 28 30 32 34
TEMPERATURE (°C)
-2.0 0 2.0 4.0
DEPTH (m)
0 20 40 60 80 100 120 140
Station 87
19 Sept '76
1346 hours
T
S

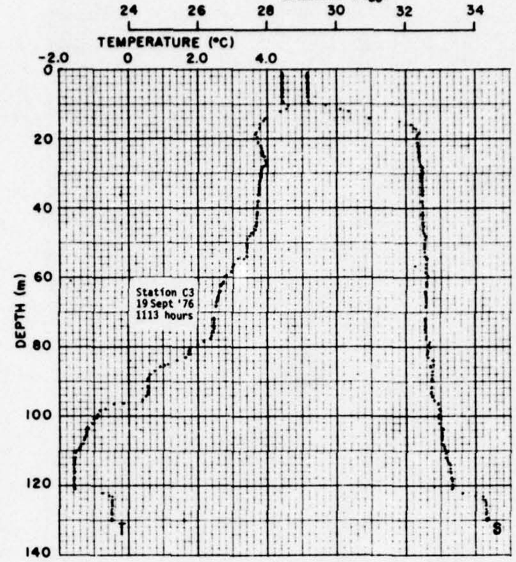

SALINITY (0/00)
TEMPERATURE (°C)
DEPTH (m)
Station B2
19 Sept '76
1409 hours
T
S

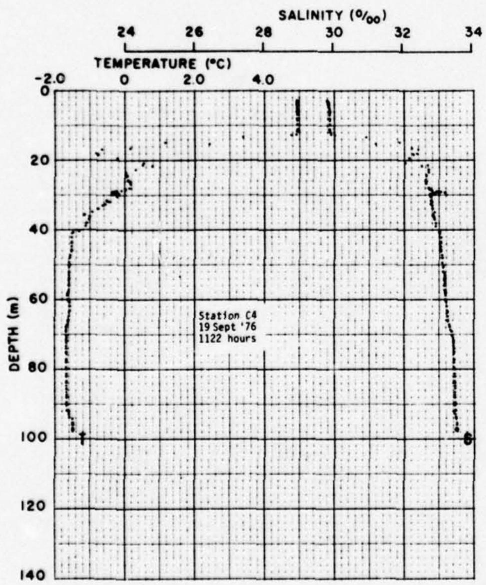

SALINITY (0/00)
TEMPERATURE (°C)
DEPTH (m)
Station B1
19 Sept '76
1430 hours
T
S

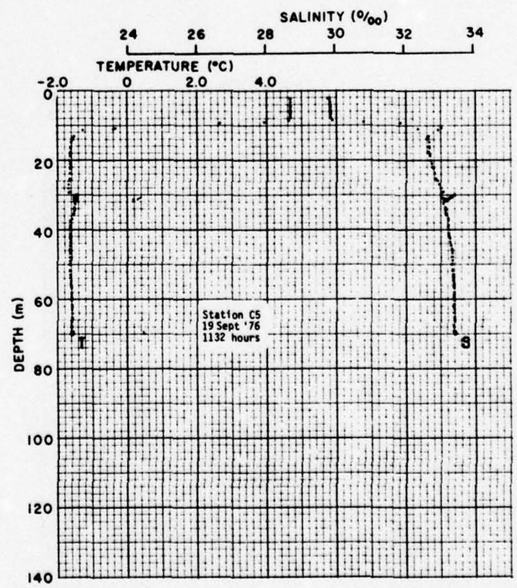

SALINITY (0/00)
TEMPERATURE (°C)
DEPTH (m)
Station B8
20 Sept '76
1900 hours
T
S

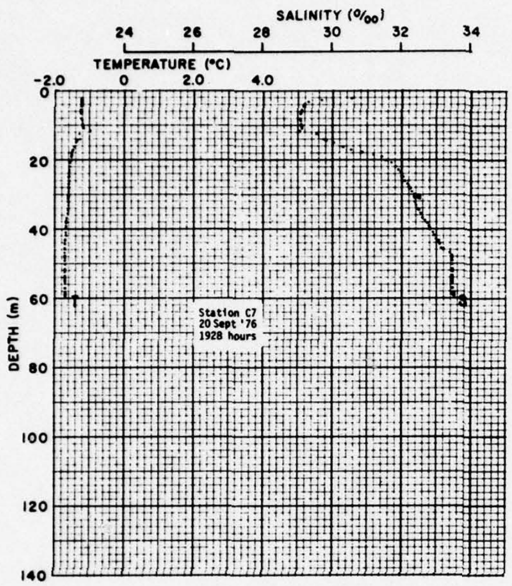

SALINITY (0/00)
TEMPERATURE (°C)
DEPTH (m)
Station C1
19 Sept '76
1050 hours
T
S


SALINITY (⁰/₀₀)
24 26 28 30 32 34
TEMPERATURE (°C)
-2.0 0 2.0 4.0
DEPTH (m)
0 20 40 60 80 100 120 140
Station C2
19 Sept '76
1100 hours
T
S

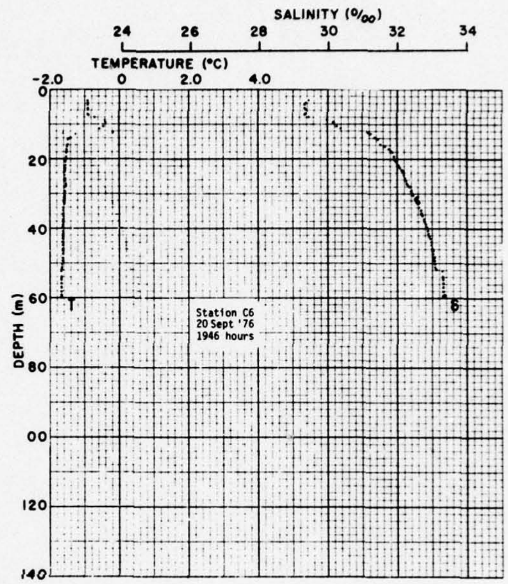

SALINITY (⁰/₀₀)
24 26 28 30 32 34
TEMPERATURE (°C)
-2.0 0 2.0 4.0
DEPTH (m)
0 20 40 60 80 100 120 140
Station C3
19 Sept '76
1113 hours
T
S


SALINITY (⁰/₀₀)
24 26 28 30 32 34
TEMPERATURE (°C)
-2.0 0 2.0 4.0
DEPTH (m)
0 20 40 60 80 100 120 140
Station C4
19 Sept '76
1122 hours
T
S


SALINITY (⁰/₀₀)
24 26 28 30 32 34
TEMPERATURE (°C)
-2.0 0 2.0 4.0
DEPTH (m)
0 20 40 60 80 100 120 140
Station C5
19 Sept '76
1132 hours
T
S



SALINITY (‰)
24 26 28 30 32 34
TEMPERATURE (°C)
-2.0 0 2.0 4.0
DEPTH (m)
0 20 40 60 80 100 120 140
Station C7
20 Sept '76
1928 hours



SALINITY (‰)
24 26 28 30 32 34
TEMPERATURE (°C)
-2.0 0 2.0 4.0
DEPTH (m)
0 20 40 60 80 00 120 140
Station C6
20 Sept '76
1946 hours

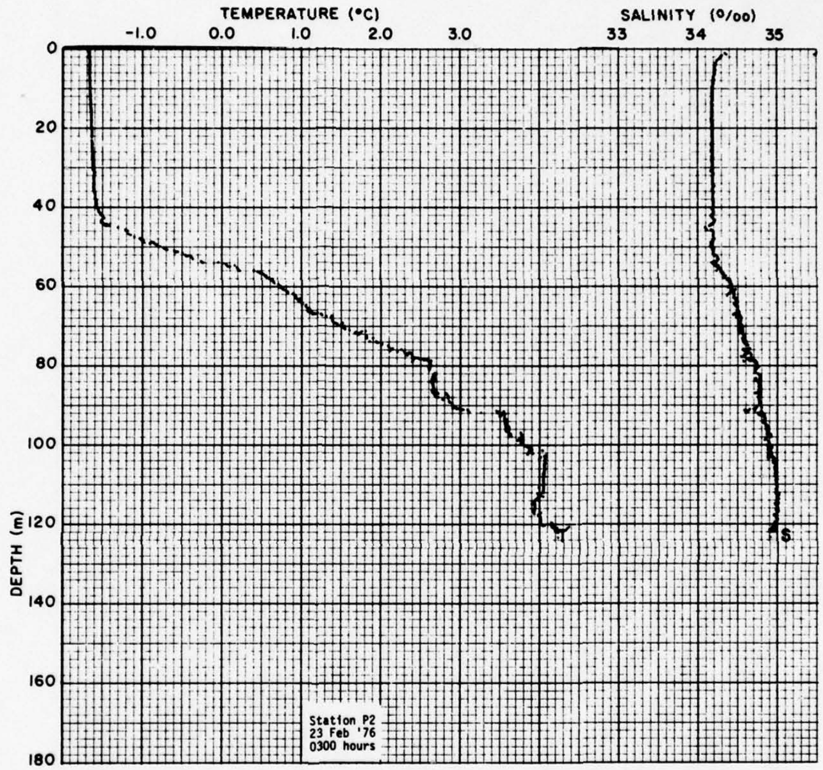
APPENDIX D

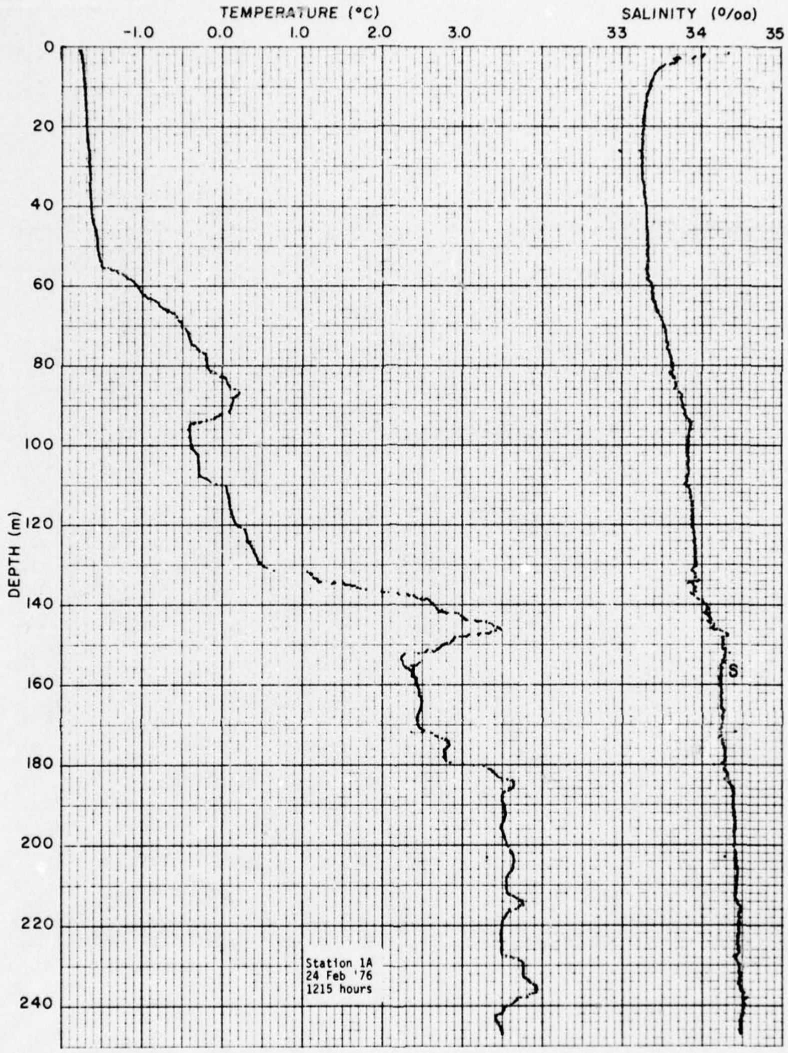
OCEANOGRAPHIC DATA FROM A CRUISE

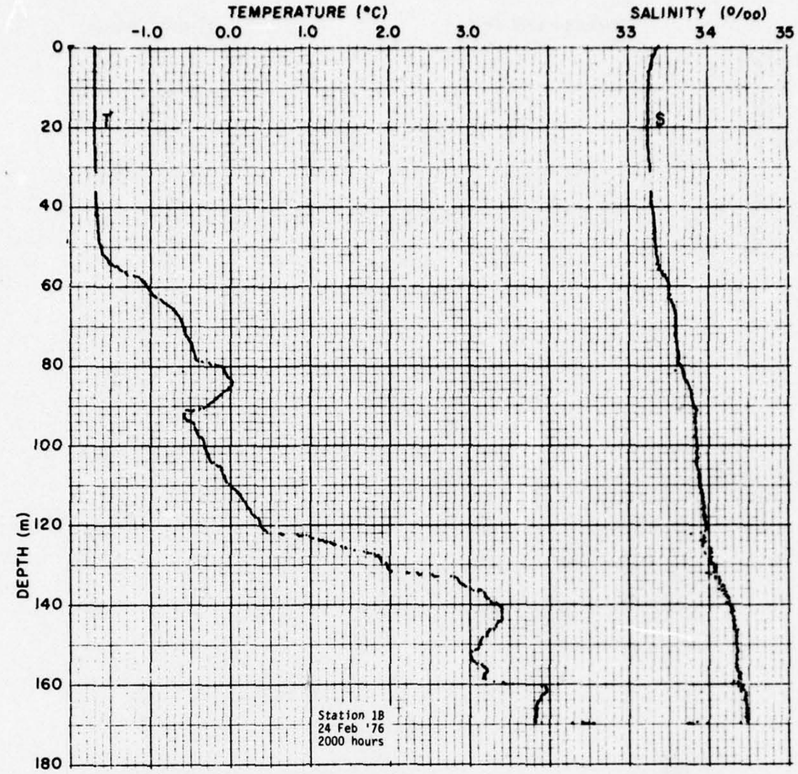
IN DAVIS STRAIT AND BAFFIN BAY

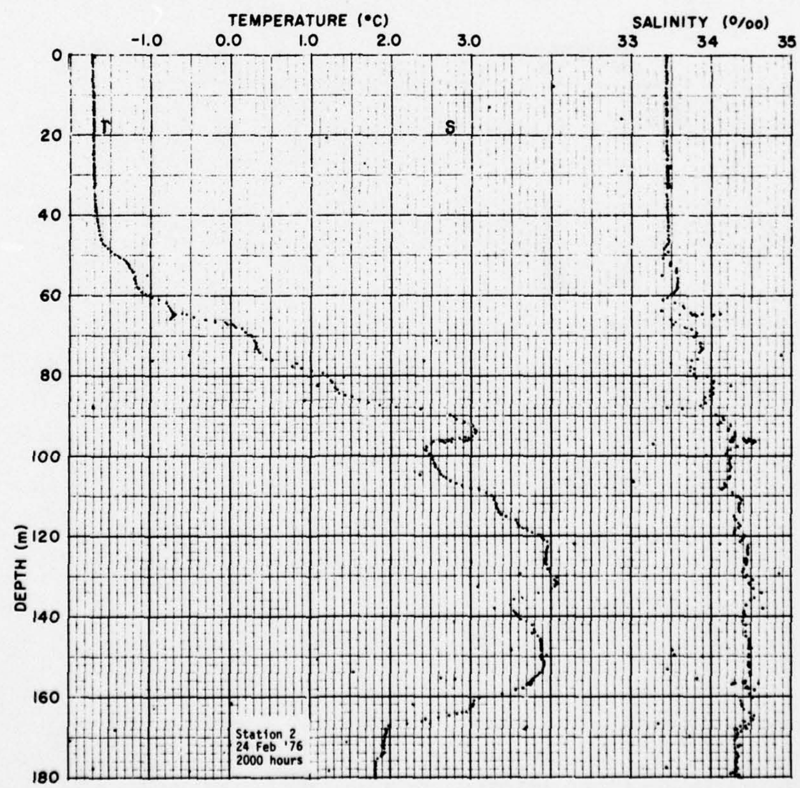
FEBRUARY-MARCH 1976

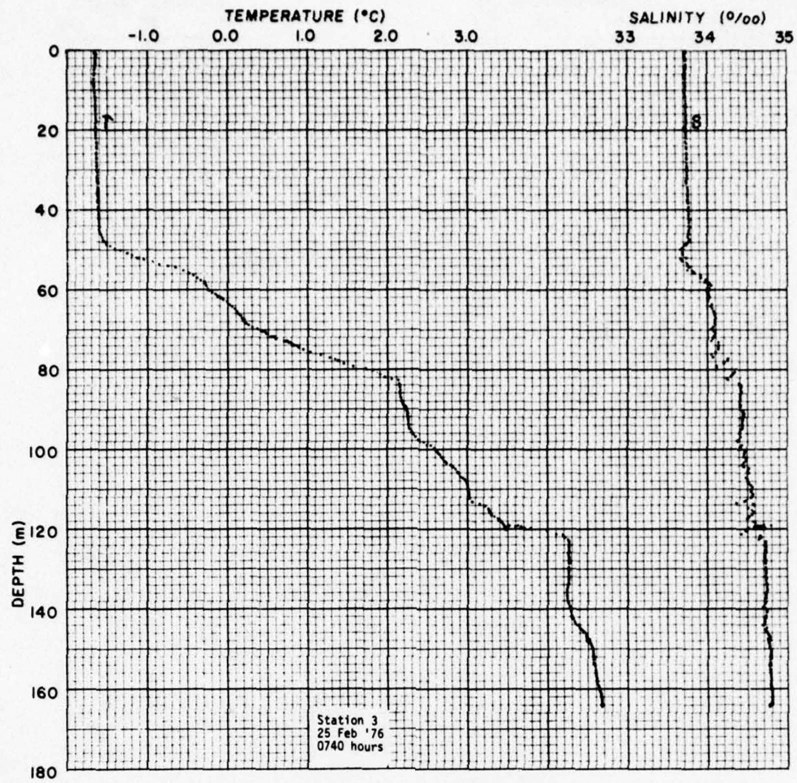
Station	Date	Time	Station	Date	Time
P2	Feb 23	0300	24	Mar 9	1545
1A	24	1215	25	10	1140
1B		2000	27	12	0115
2		2000	28		1250
3	25	0740	29	13	0000
4		1345	30		1050
5		1915	31		1411
6	26	0500	34	14	1330
7		0615	35		2345
8		1200	36	15	1810
9		1550	37	16	0105
10	27	1510	38		1356
11	28	1600	39	17	0050
13	29	1530	40		1505
14	Mar 2	0001	41	18	0005
15		1845	42		1600
16		2400	43		1950
17	3	1300	45		1100
18		2330	45A	19	1245
19	5	0015	46		1640
20	6	0055	47		2355
21	7	0130	48	20	1050
22		1110			
23	8	1400			

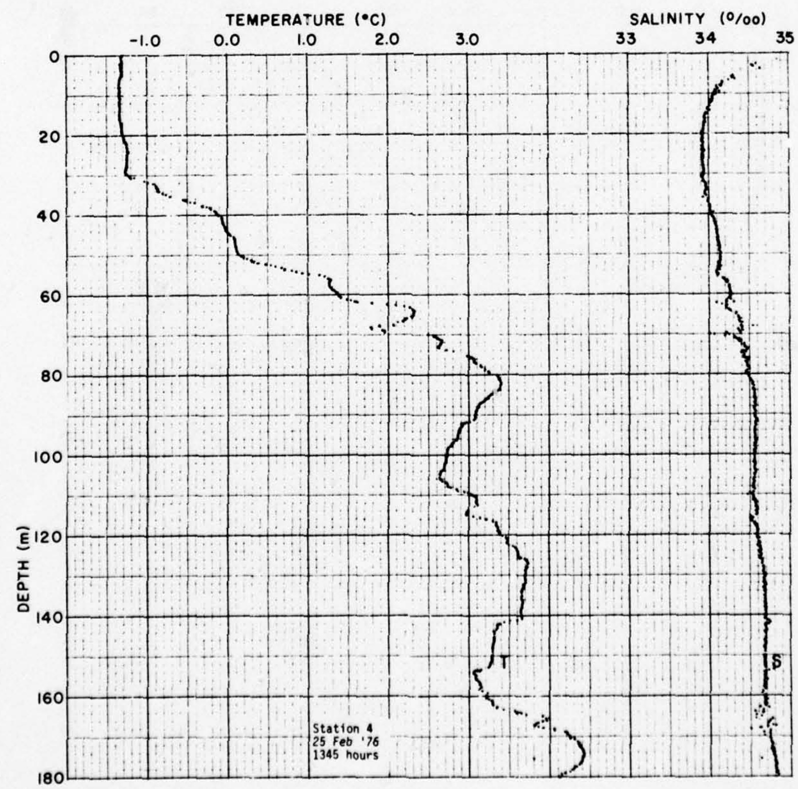

TEMPERATURE (°C)
-1.0
0.0
1.0
2.0
3.0
SALINITY (°/oo)
33
34
35
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
T
S
Station P2
23 Feb '76
0300 hours

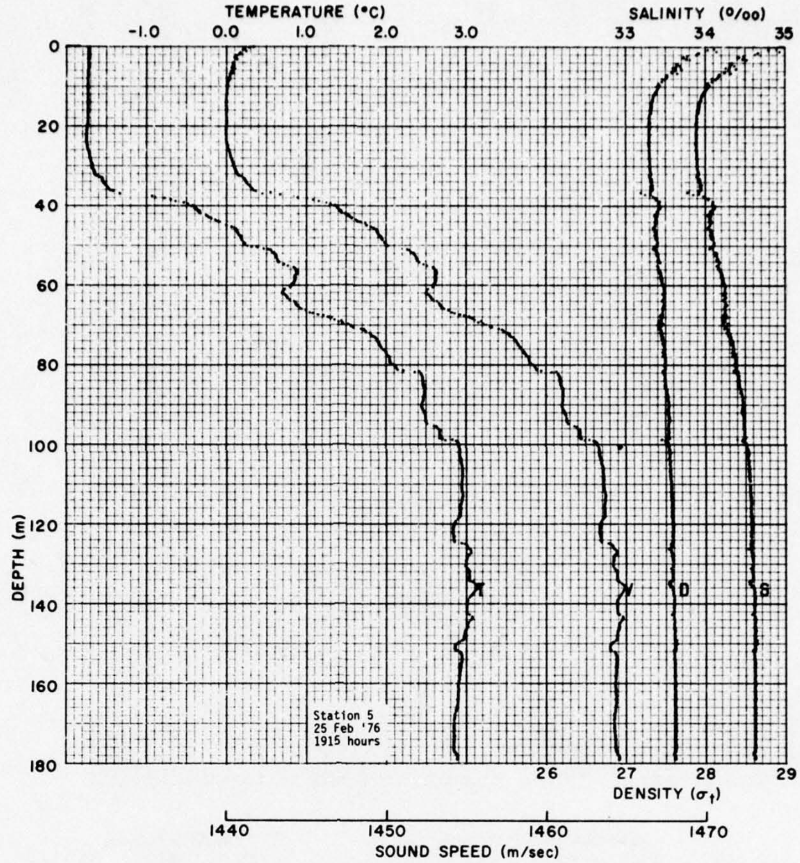

TEMPERATURE (°C)
-1.0
0.0
1.0
2.0
3.0
SALINITY (0/oo)
33
34
35
0
20
40
60
80
100
120
140
160
180
200
220
240
DEPTH (m)
S
Station 1A
24 Feb '76
1215 hours

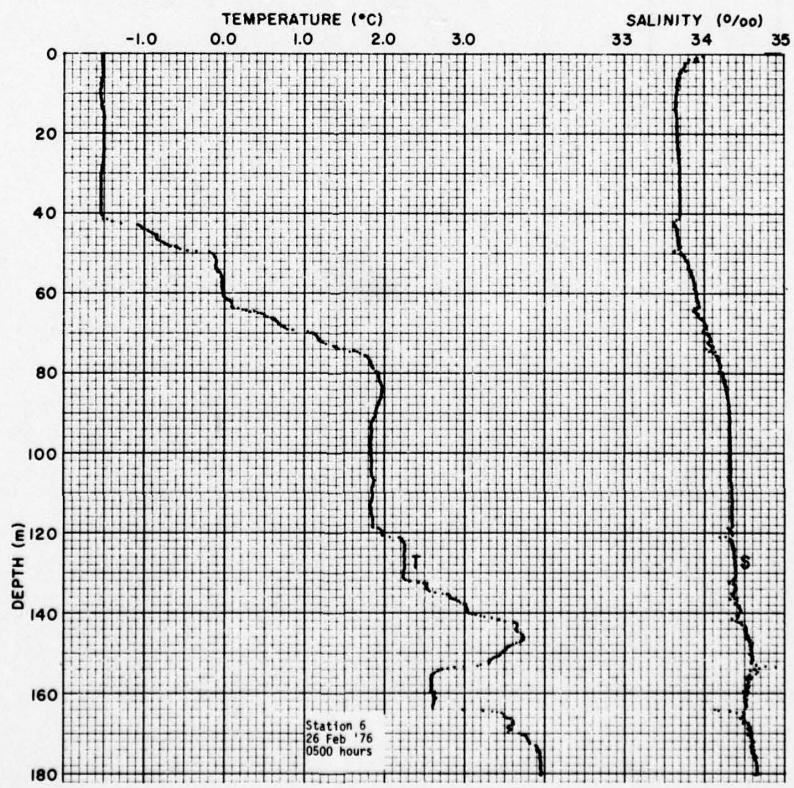

TEMPERATURE (°C)
-1.0 0.0 1.0 2.0 3.0
SALINITY (0/00)
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
T
S
Station 1B
24 Feb '76
2000 hours

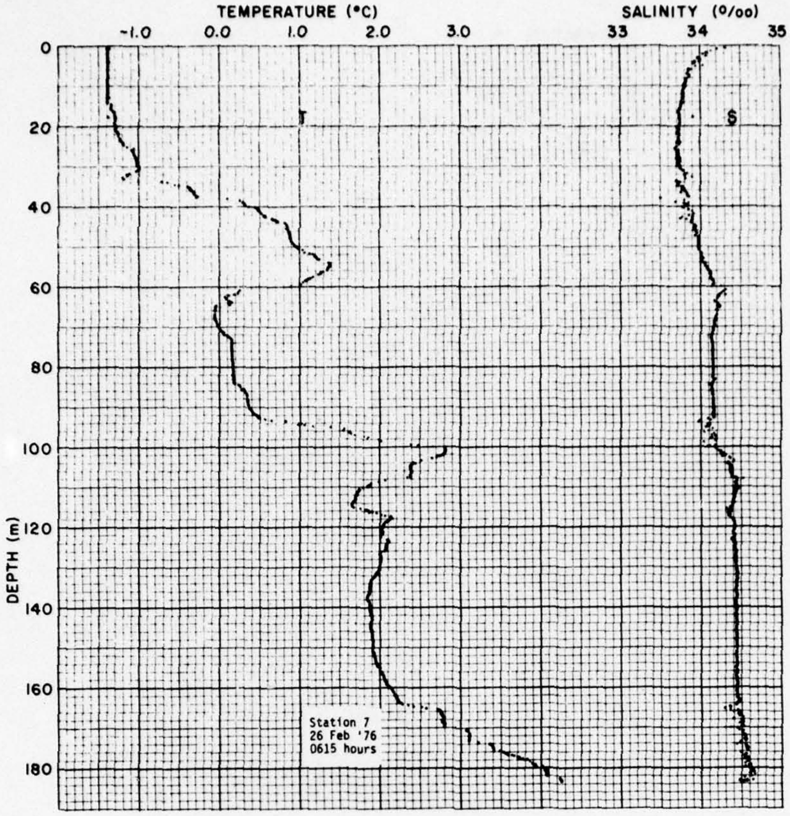

TEMPERATURE (°C)
-1.0 0.0 1.0 2.0 3.0
SALINITY (0/00)
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
T
S
Station 2
24 Feb '76
2000 hours

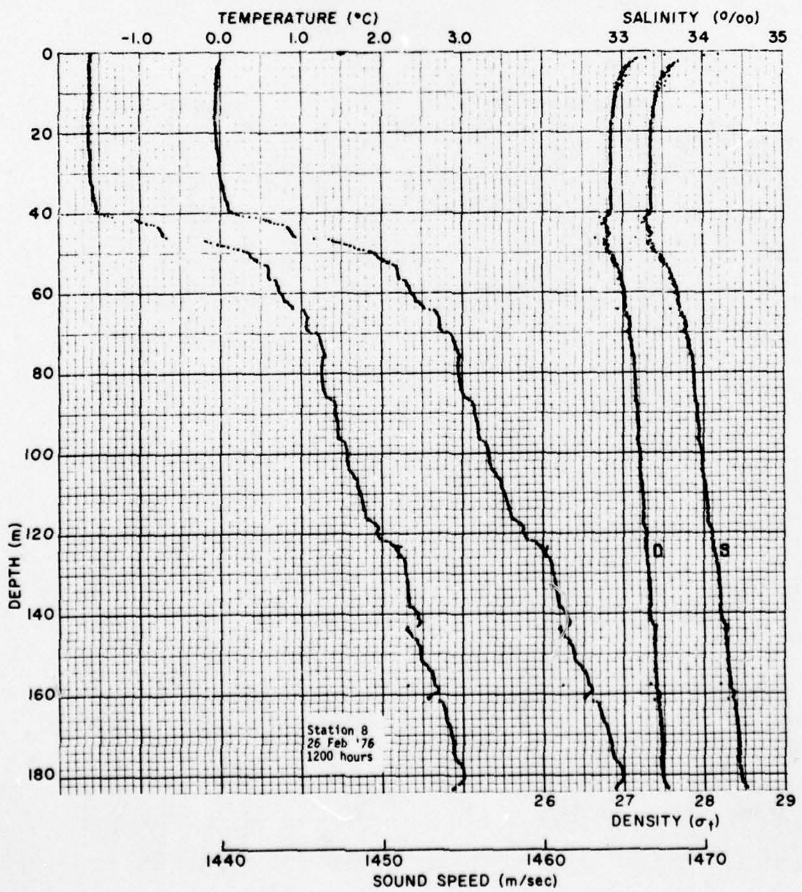

TEMPERATURE (°C)
SALINITY (0/00)
-1.0
0.0
1.0
2.0
3.0
33
34
35
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
T
S
Station 3
25 Feb '76
0740 hours

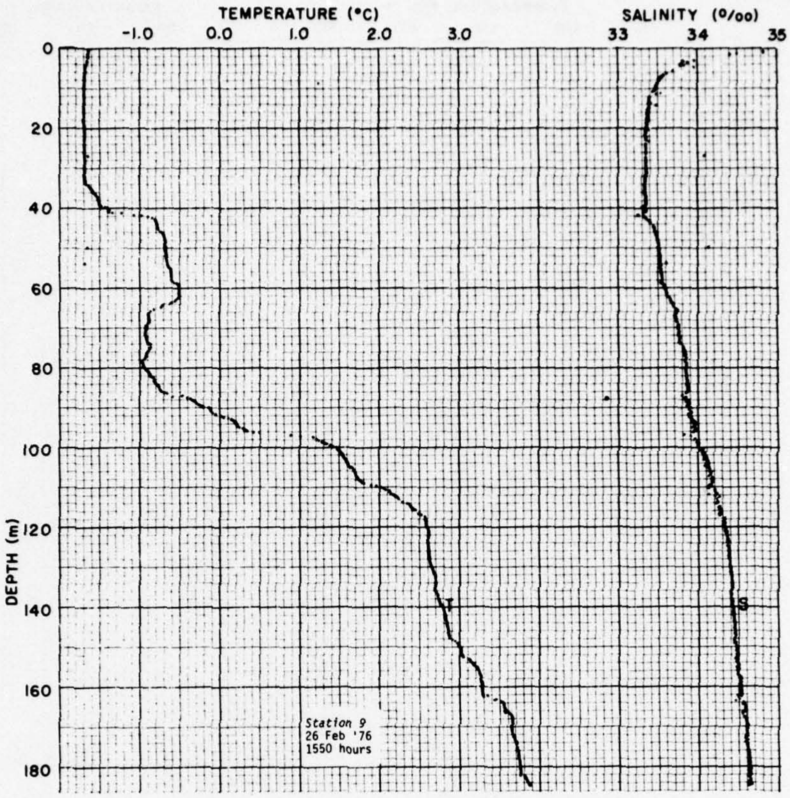

TEMPERATURE (°C)
SALINITY (0/00)
-1.0
0.0
1.0
2.0
3.0
33
34
35
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
T
S
Station 4
25 Feb '76
1345 hours


TEMPERATURE (°C)
-1.0
0.0
1.0
2.0
3.0
SALINITY (0/oo)
33
34
35
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
T
V
D
S
Station 5
25 Feb '76
1915 hours
26
27
28
29
DENSITY (σ_t)
1440
1450
1460
1470
SOUND SPEED (m/sec)

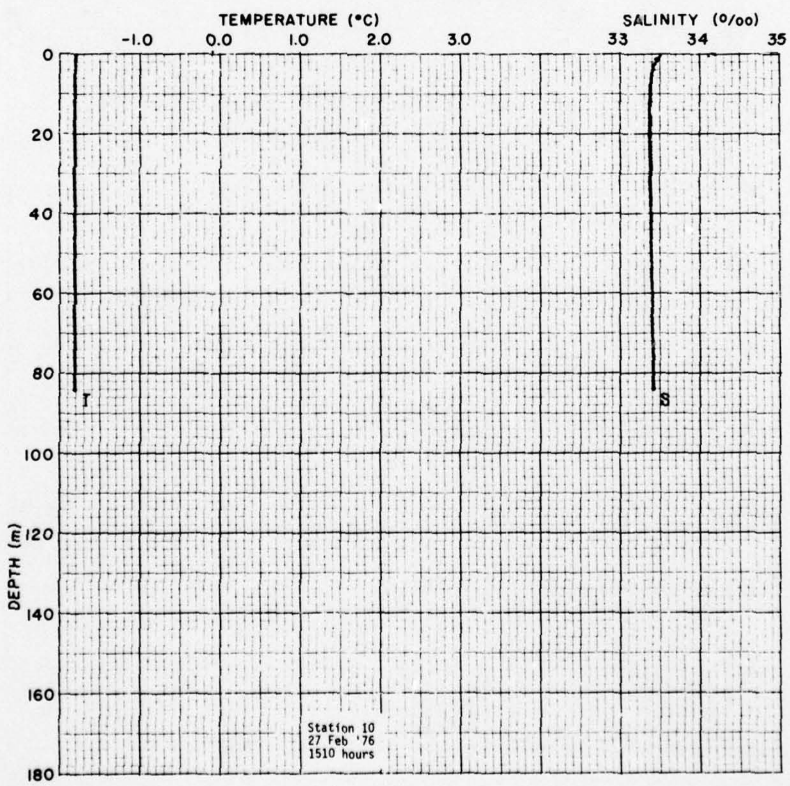

TEMPERATURE (°C)
-1.0
0.0
1.0
2.0
3.0
SALINITY (0/oo)
33
34
35
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
T
S
Station 6
26 Feb '76
0500 hours


TEMPERATURE (°C)
SALINITY (0/oo)
DEPTH (m)
Station 7
26 Feb '76
0615 hours

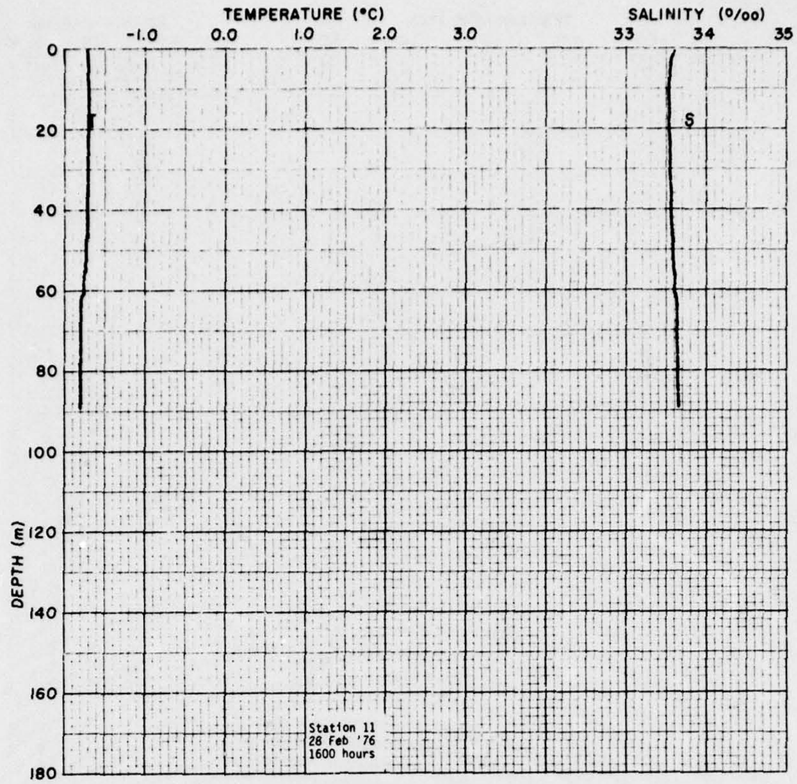

TEMPERATURE (°C)
SALINITY (0/oo)
DEPTH (m)
D
S
Station 8
26 Feb '76
1200 hours
DENSITY (σ_t)
SOUND SPEED (m/sec)

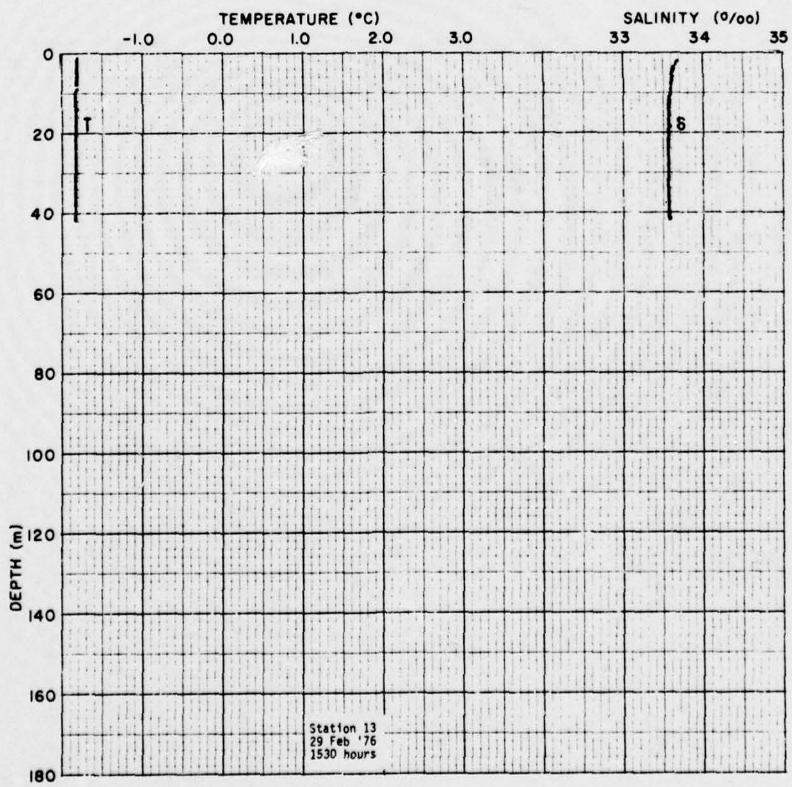


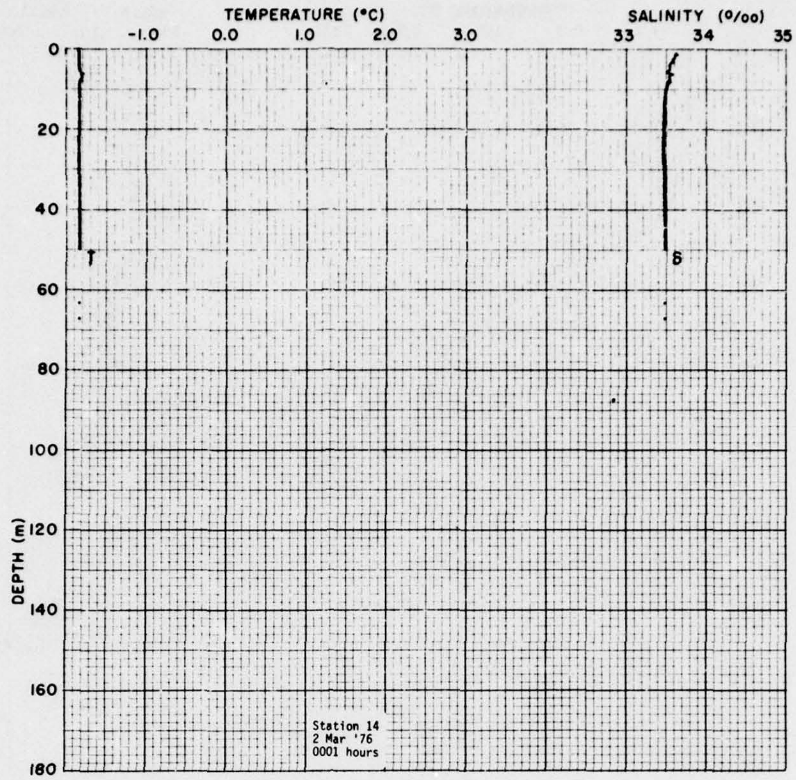
TEMPERATURE (°C)
SALINITY (0/oo)
-1.0 0.0 1.0 2.0 3.0
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
T
S
Station 9
26 Feb '76
1550 hours

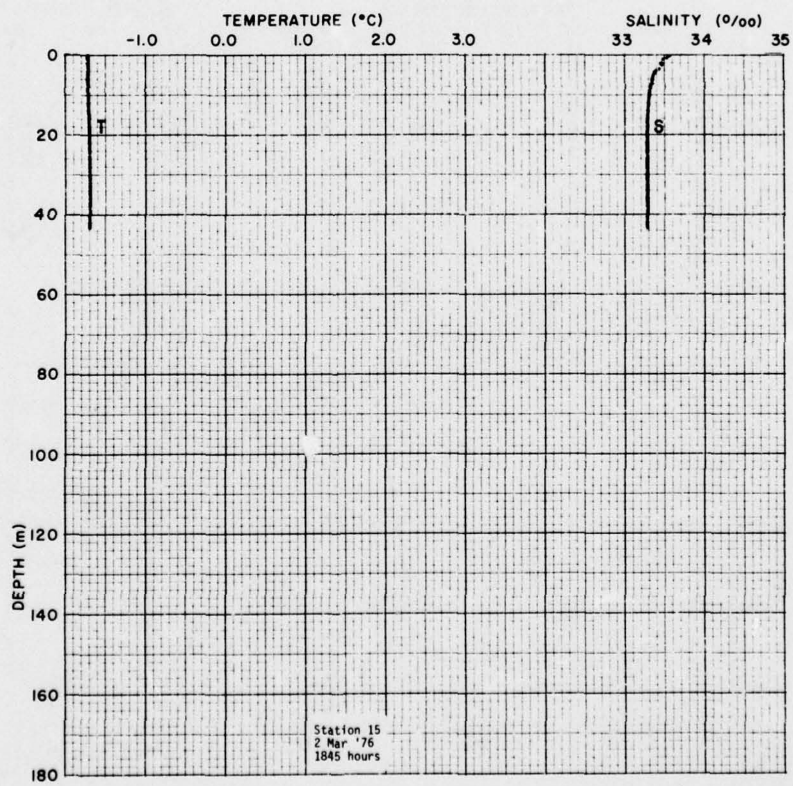


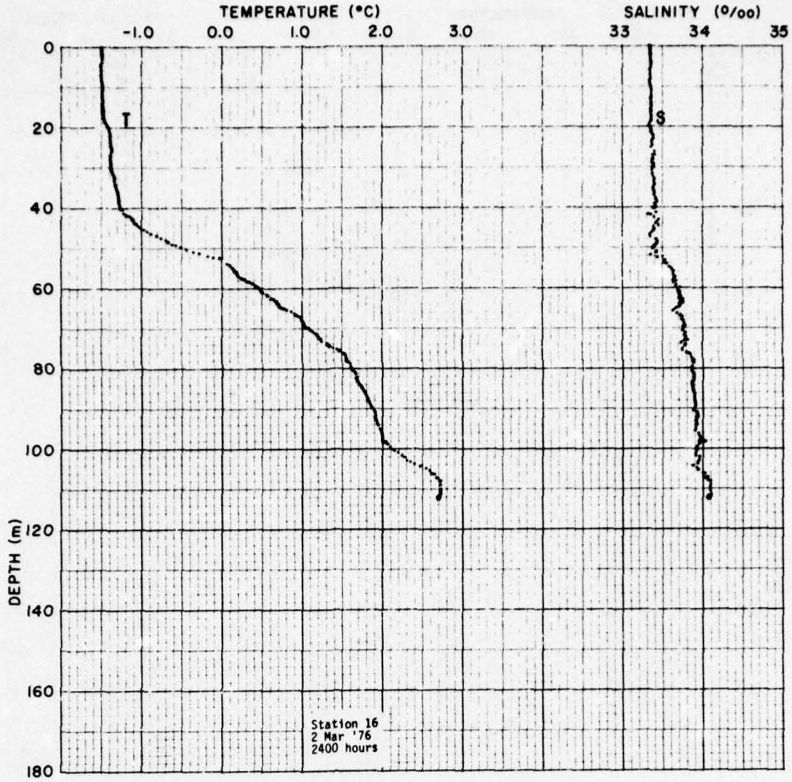
TEMPERATURE (°C)
SALINITY (0/oo)
-1.0 0.0 1.0 2.0 3.0
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
T
S
Station 10
27 Feb '76
1510 hours

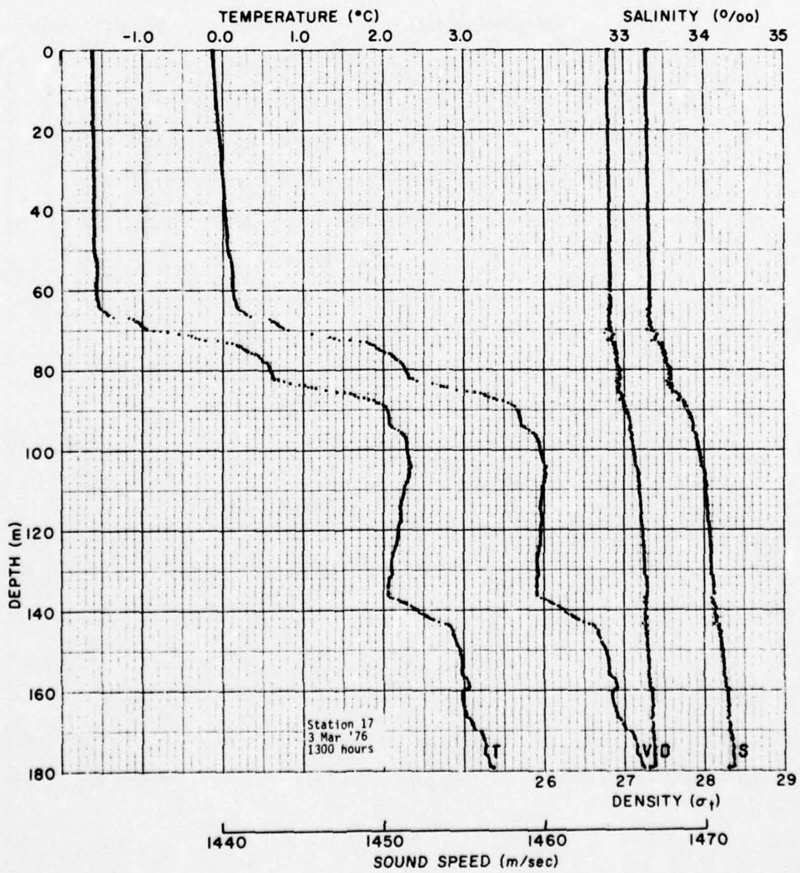

TEMPERATURE (°C)
-1.0 0.0 1.0 2.0 3.0
SALINITY (0/oo)
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
T
S
Station 11
28 Feb '76
1600 hours

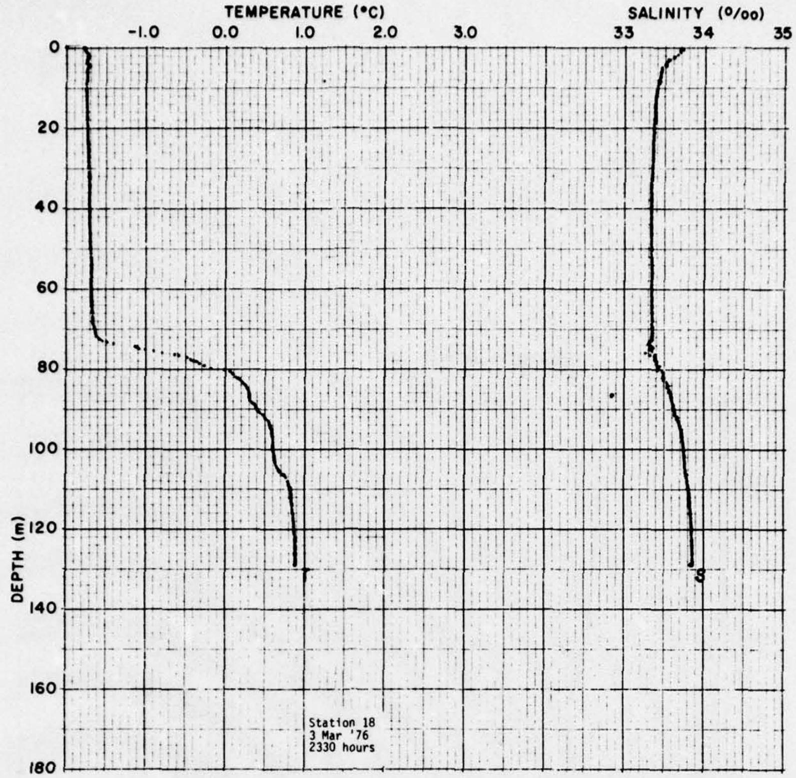

TEMPERATURE (°C)
-1.0 0.0 1.0 2.0 3.0
SALINITY (0/oo)
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
T
S
Station 13
29 Feb '76
1530 hours

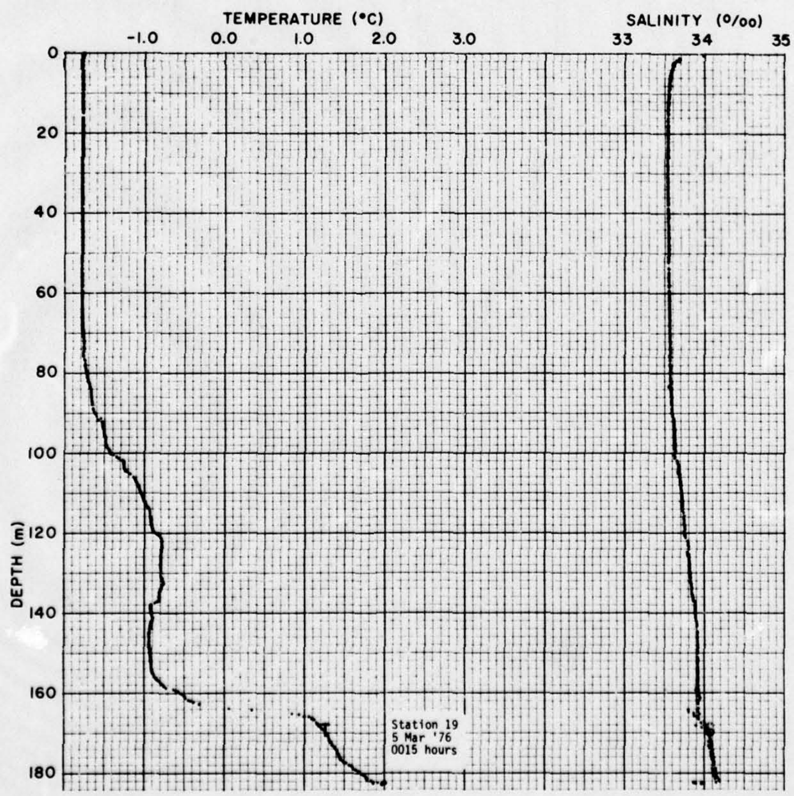

TEMPERATURE (°C)
-1.0 0.0 1.0 2.0 3.0
SALINITY (0/oo)
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
T
S
Station 14
2 Mar '76
0001 hours

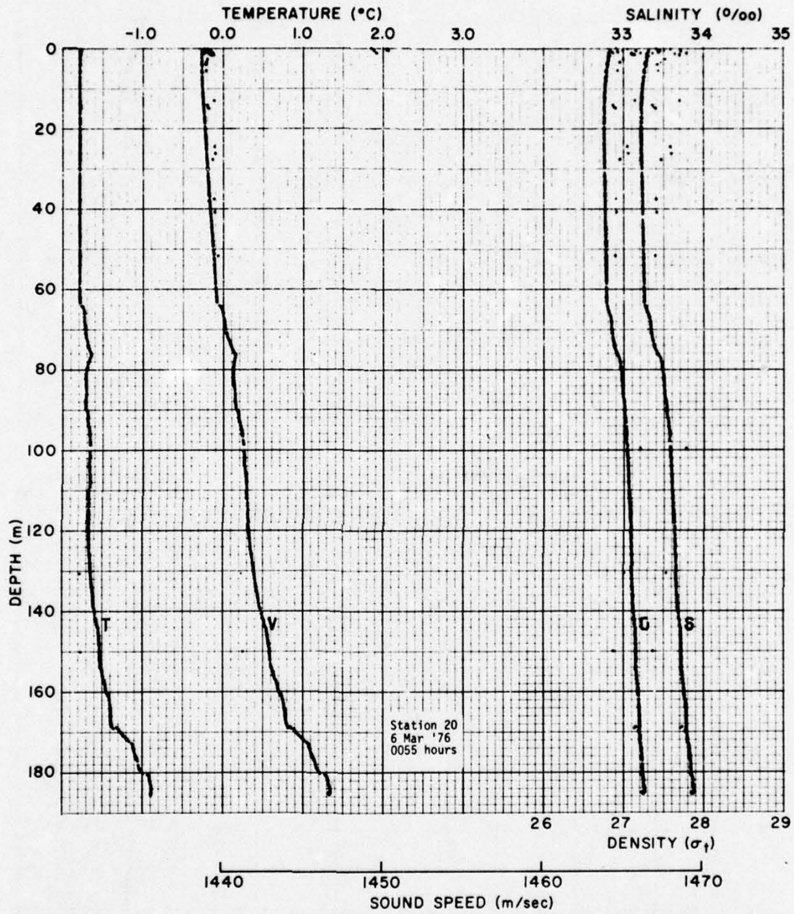

TEMPERATURE (°C)
-1.0 0.0 1.0 2.0 3.0
SALINITY (0/oo)
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
T
S
Station 15
2 Mar '76
1845 hours

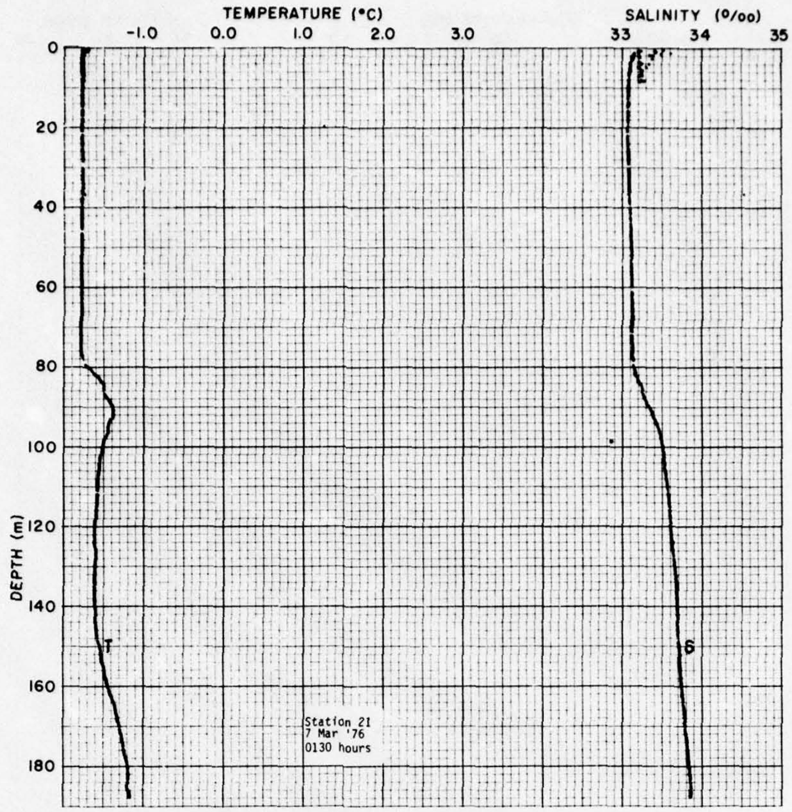

TEMPERATURE (°C)
-1.0 0.0 1.0 2.0 3.0
SALINITY (0/oo)
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
T
S
Station 16
2 Mar '76
2400 hours

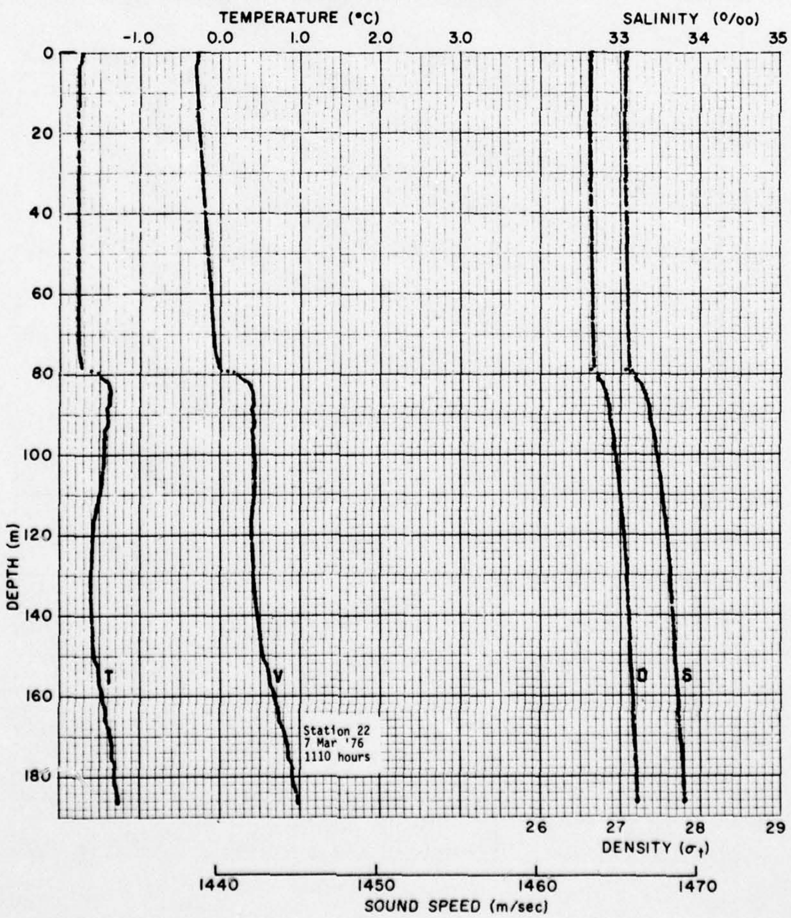

TEMPERATURE (°C)
-1.0 0.0 1.0 2.0 3.0
SALINITY (0/oo)
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
Station 17
3 Mar '76
1300 hours
T
V
D
S
26 27 28 29
DENSITY (σ_t)
1440 1450 1460 1470
SOUND SPEED (m/sec)

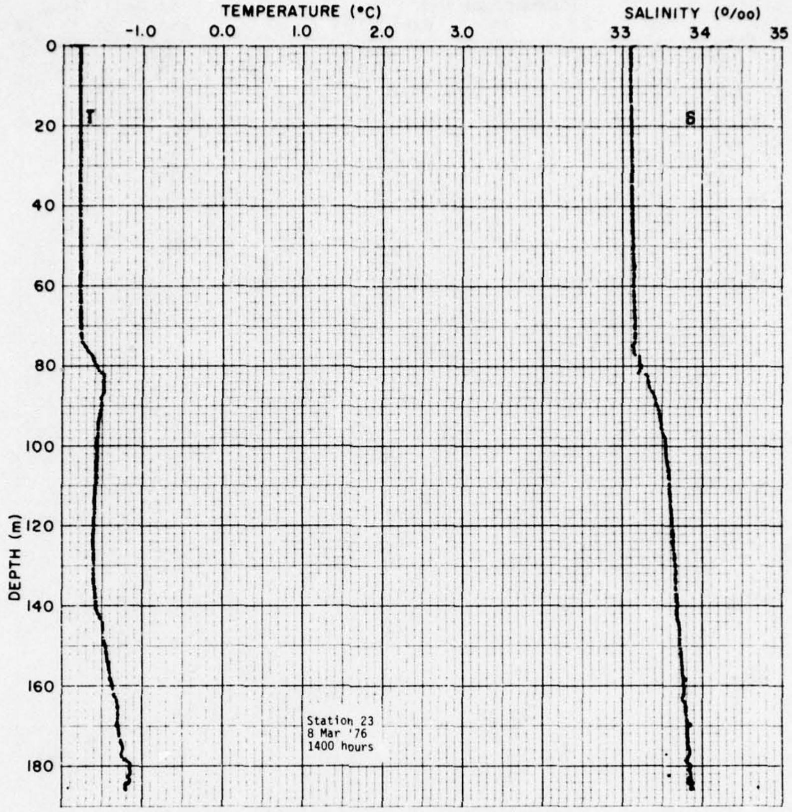

TEMPERATURE (°C)
-1.0 0.0 1.0 2.0 3.0
SALINITY (0/oo)
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
Station 18
3 Mar '76
2330 hours


TEMPERATURE (°C)
-1.0 0.0 1.0 2.0 3.0
SALINITY (0/oo)
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
Station 19
5 Mar '76
0015 hours


TEMPERATURE (°C)
-1.0
0.0
1.0
2.0
3.0
SALINITY (0/oo)
33
34
35
DEPTH (m)
0
20
40
60
80
100
120
140
160
180
T
V
σ
S
Station 20
6 Mar '76
0055 hours
26
27
28
29
DENSITY (σ_t)
1440
1450
1460
1470
SOUND SPEED (m/sec)


TEMPERATURE (°C)
-1.0 0.0 1.0 2.0 3.0
SALINITY (0/oo)
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
T
S
Station 21
7 Mar '76
0130 hours


TEMPERATURE (°C)
-1.0 0.0 1.0 2.0 3.0
SALINITY (0/oo)
33 34 35
DEPTH (m)
0 20 40 60 80 100 120 140 160 180
T
V
D
S
Station 22
7 Mar '76
1110 hours
26 27 28 29
DENSITY (σ_t)
1440 1450 1460 1470
SOUND SPEED (m/sec)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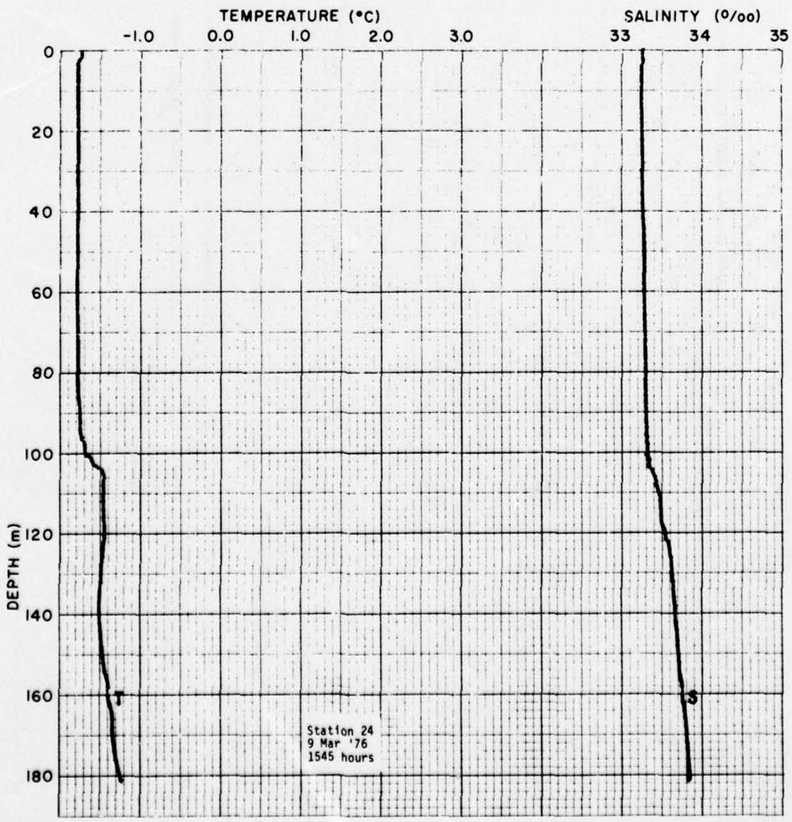
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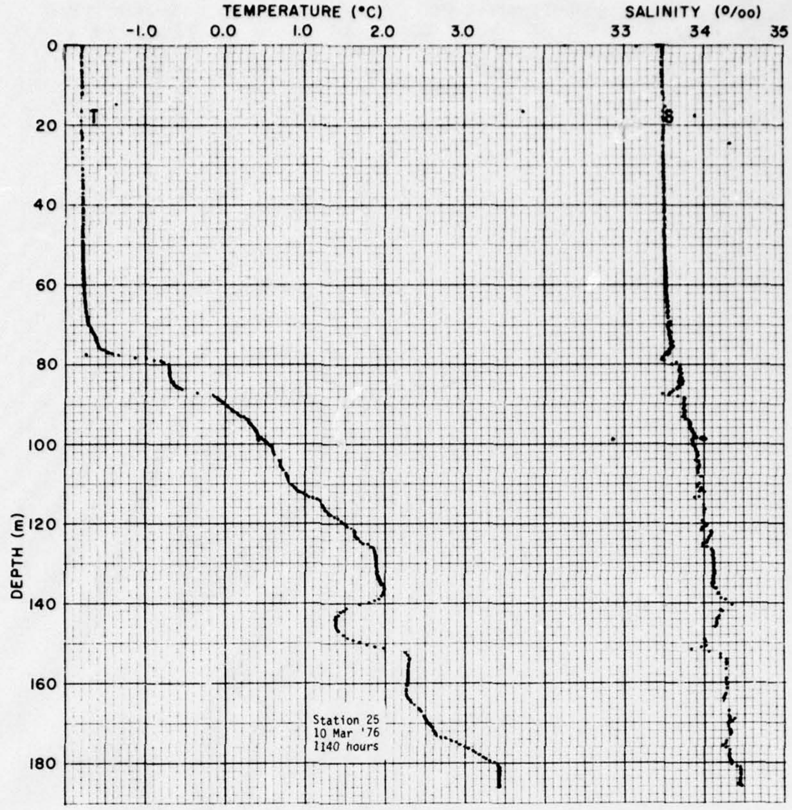
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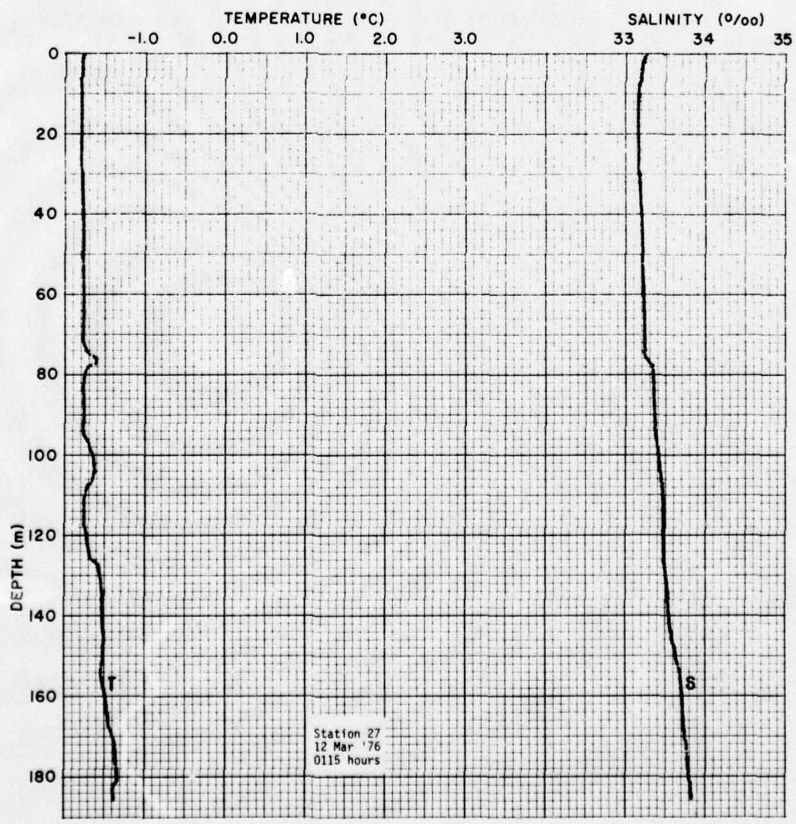
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Station 27
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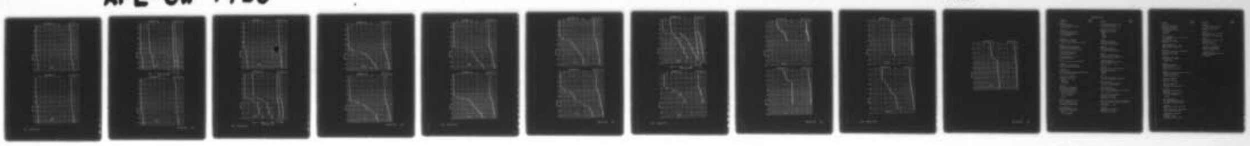

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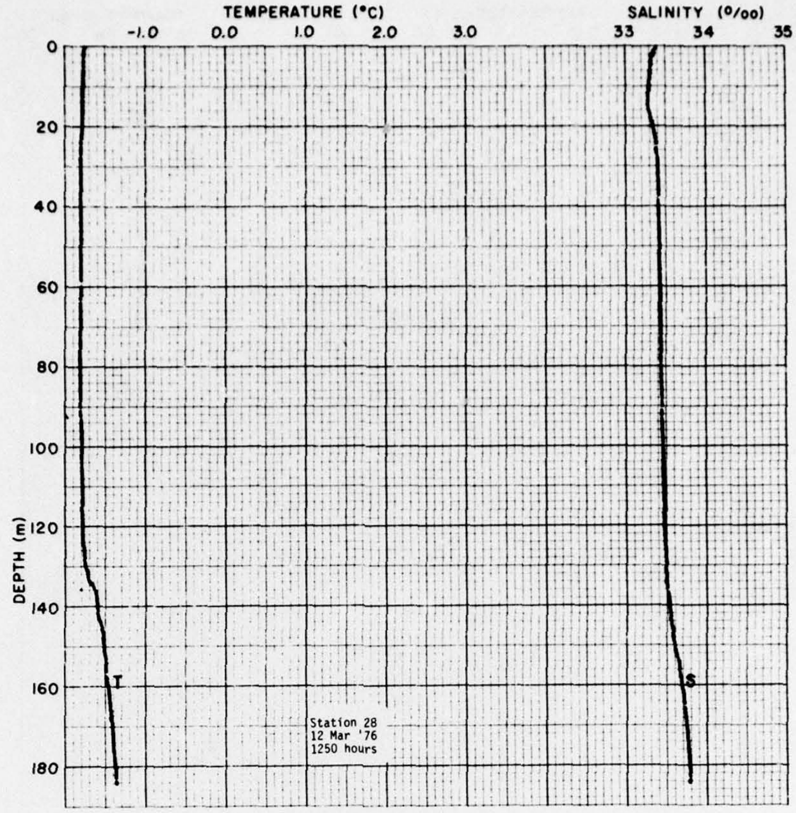
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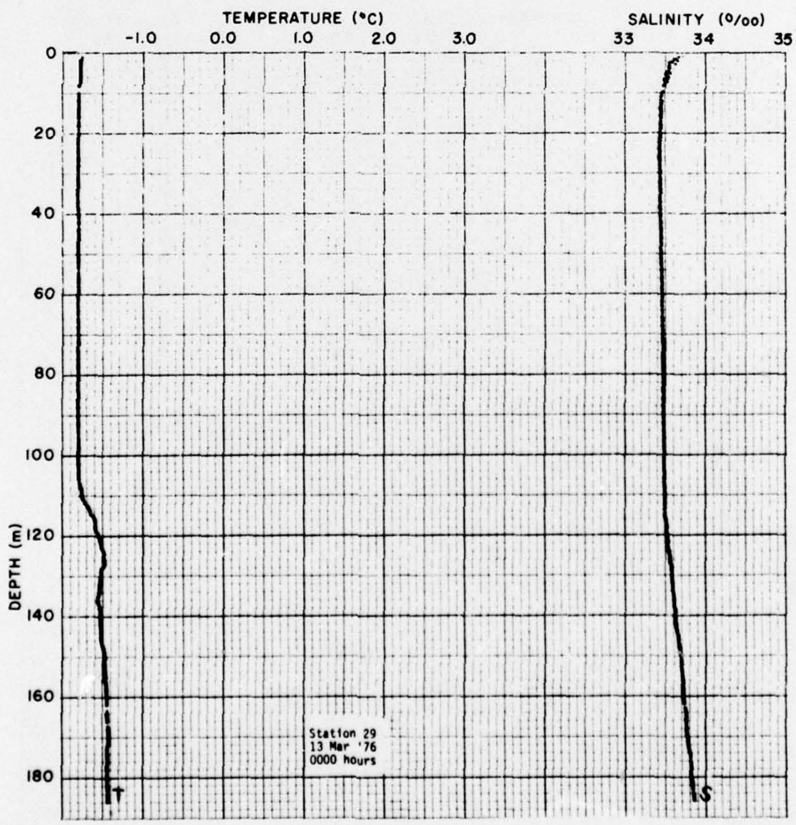
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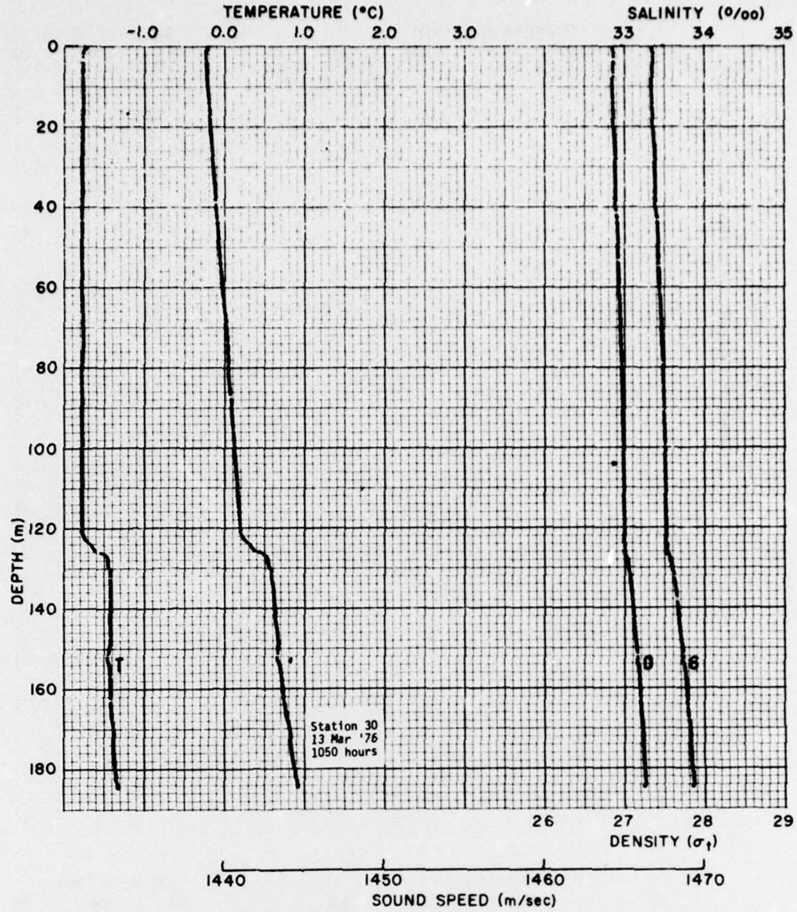
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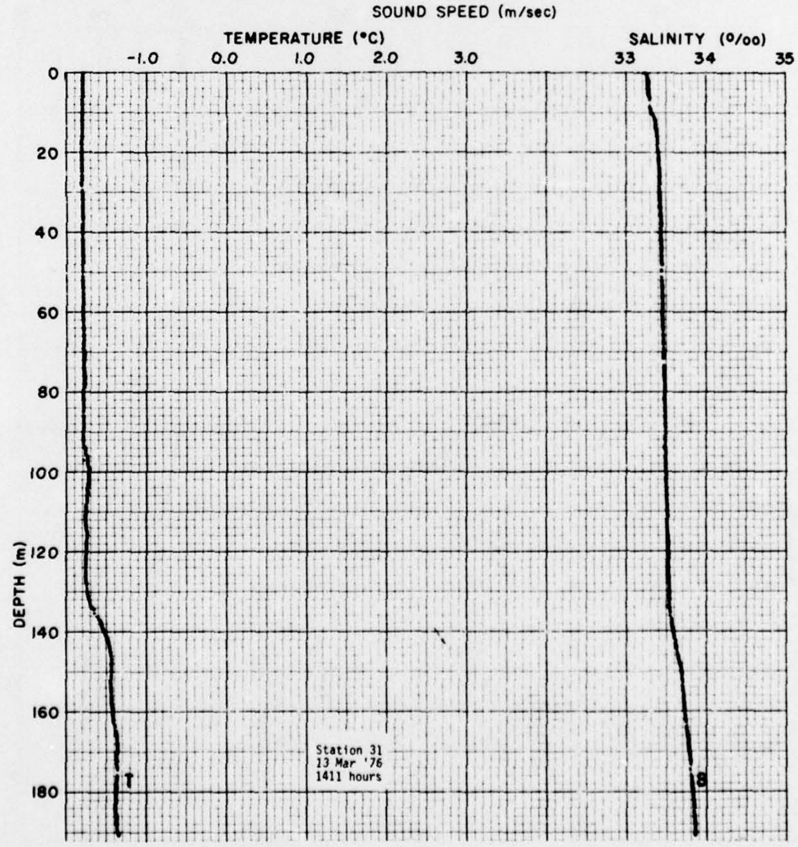
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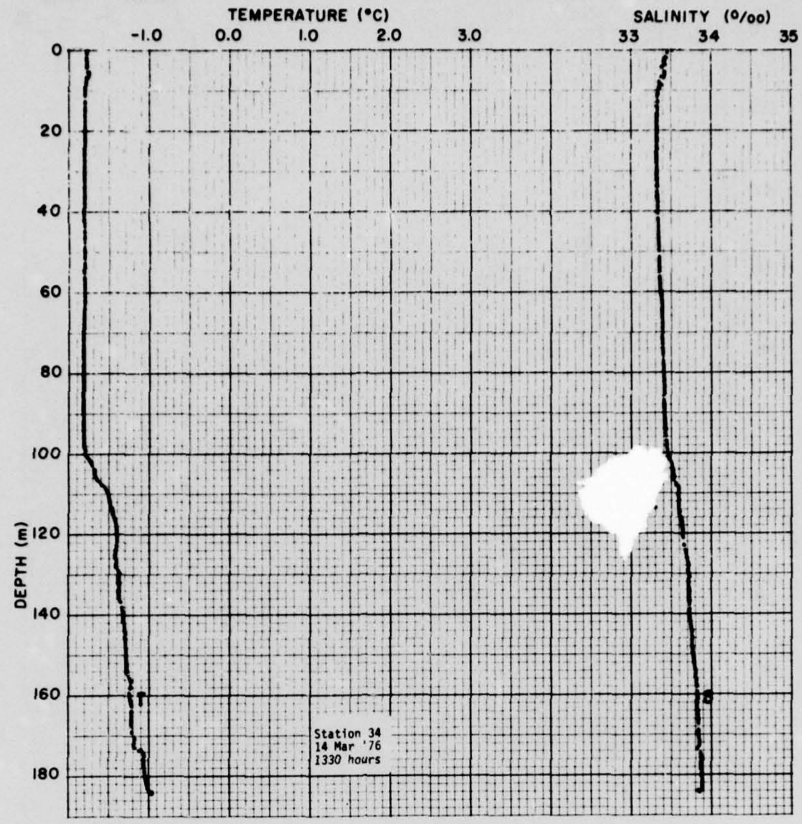
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Station 34
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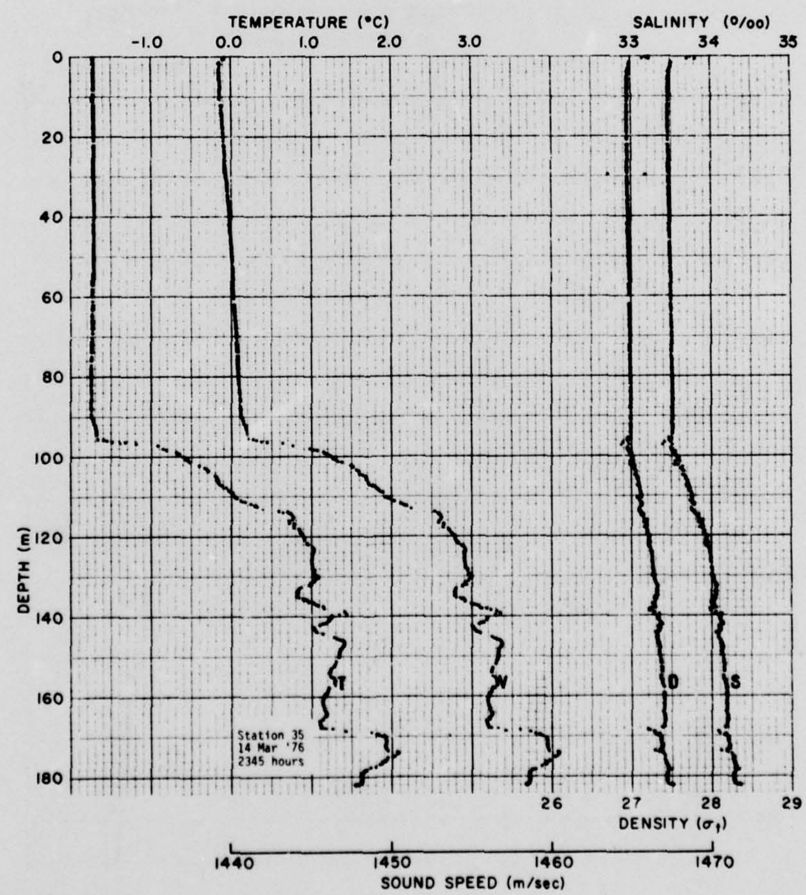
1330 hours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14 Mar '76
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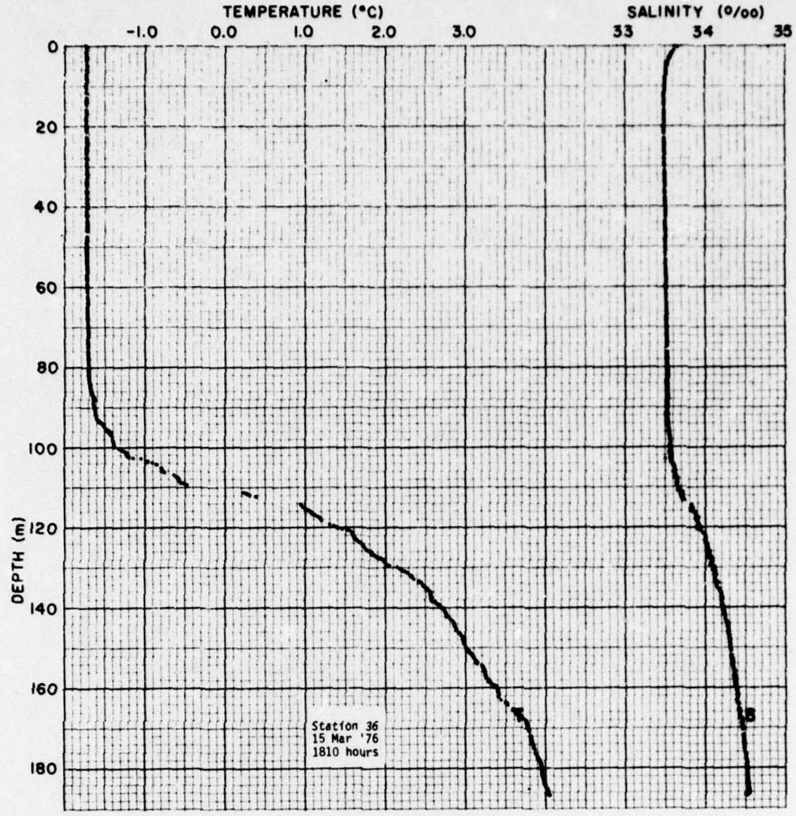
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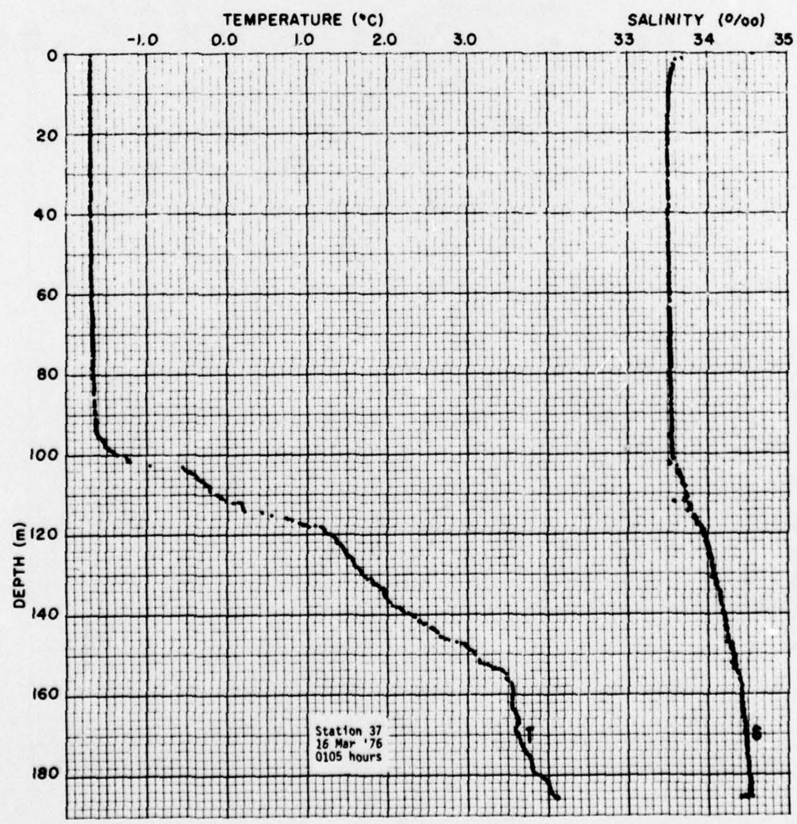
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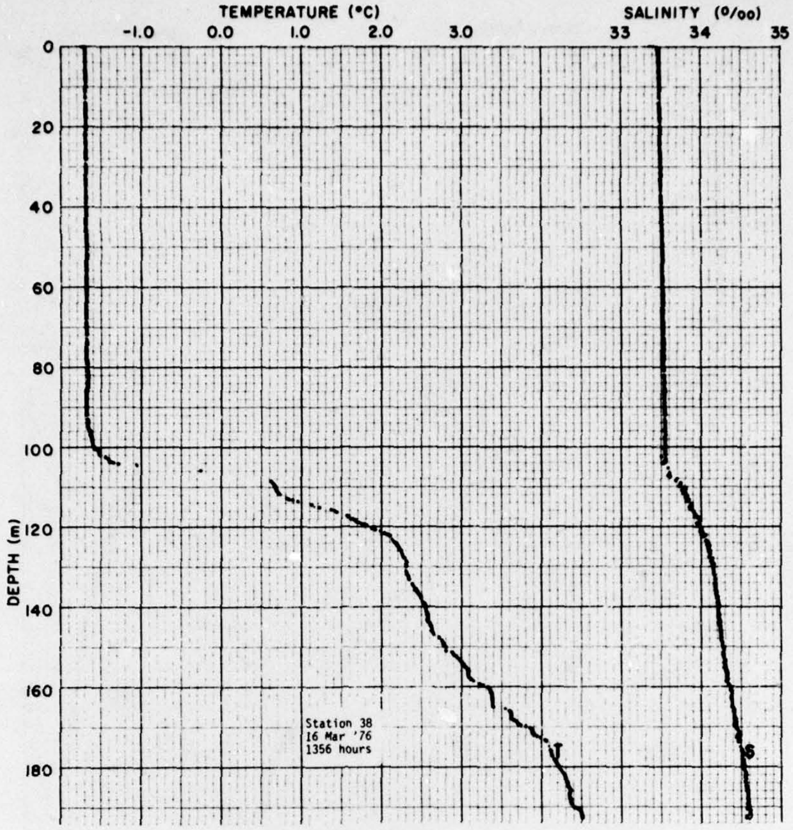
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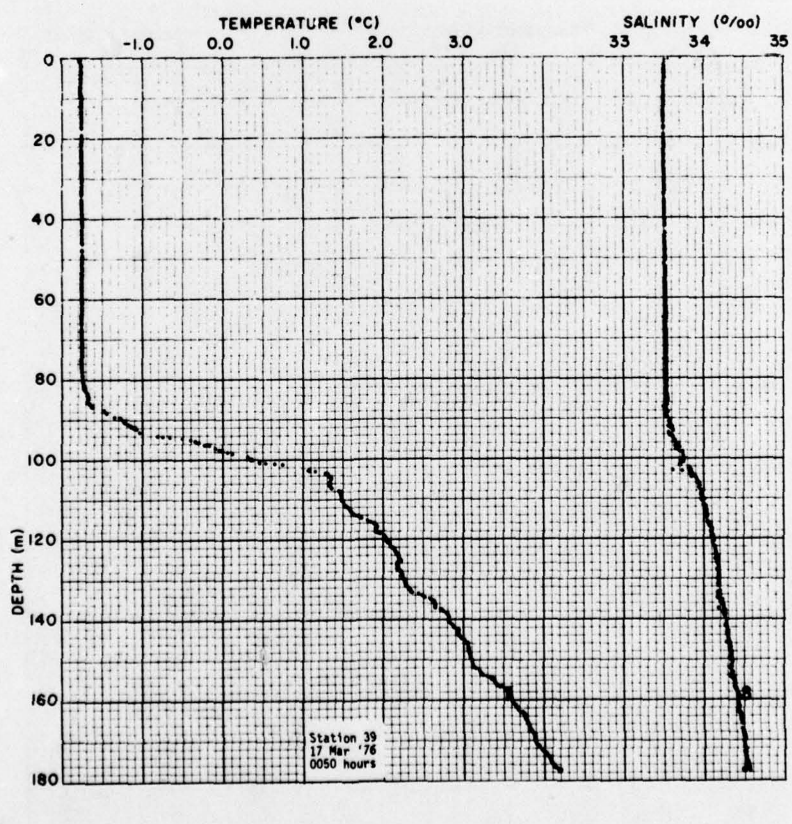
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Station 39
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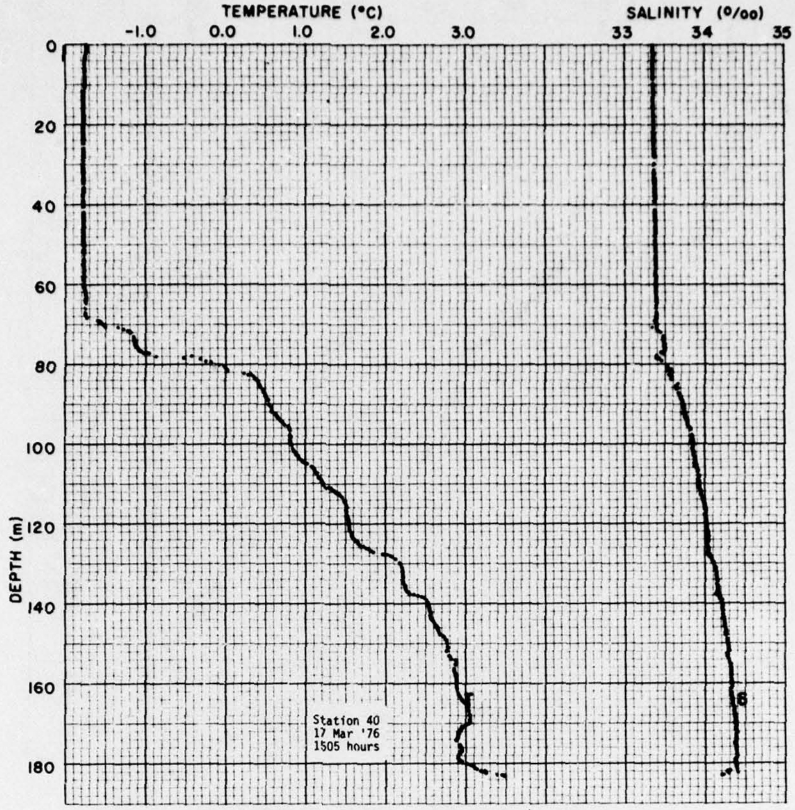
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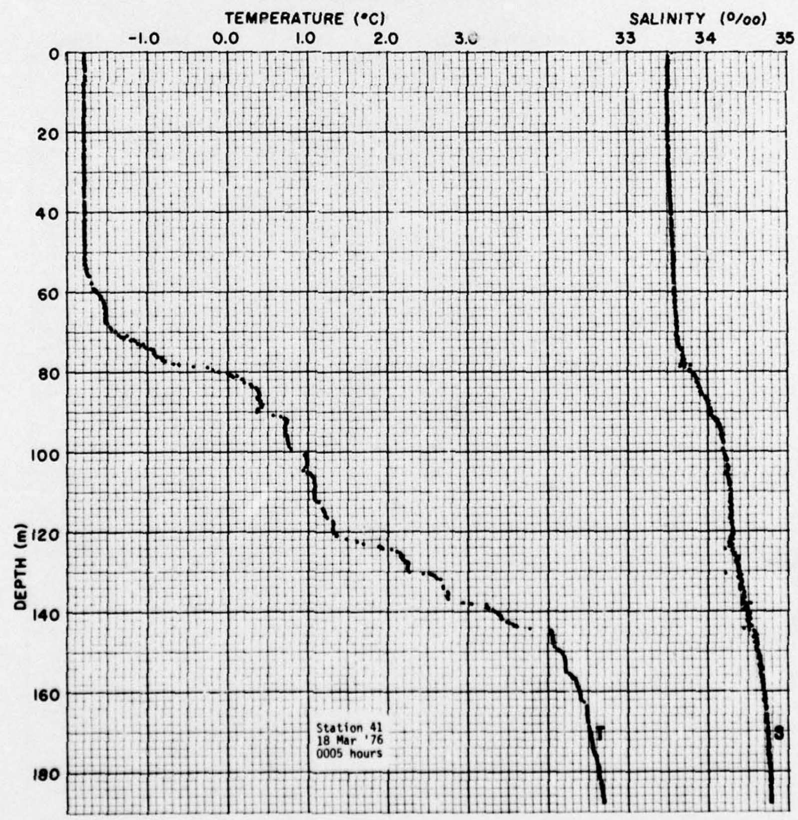
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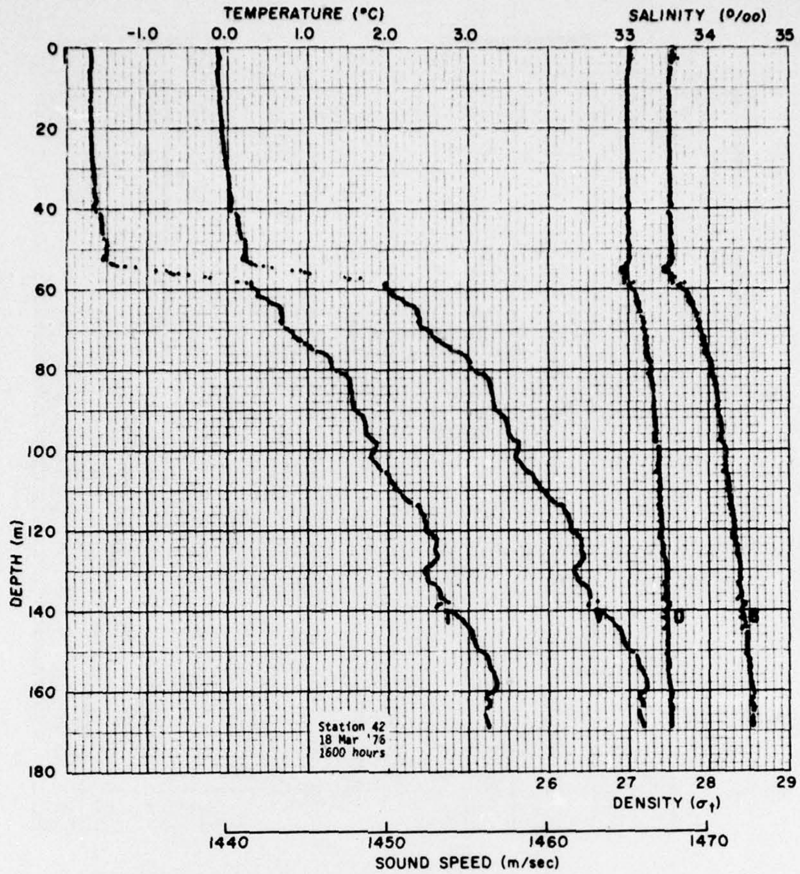
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DENSITY (σ_t)
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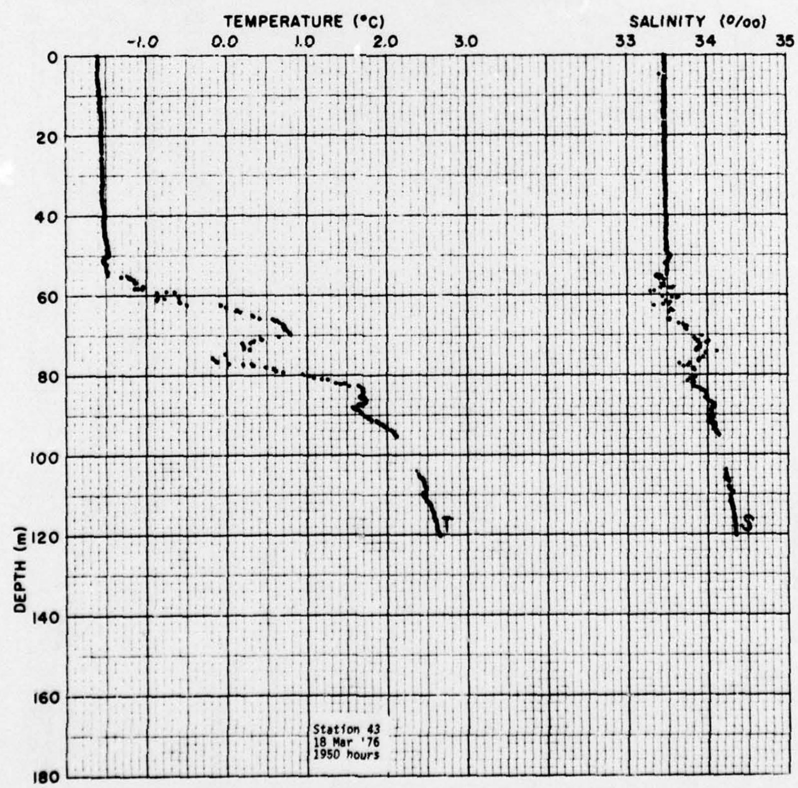
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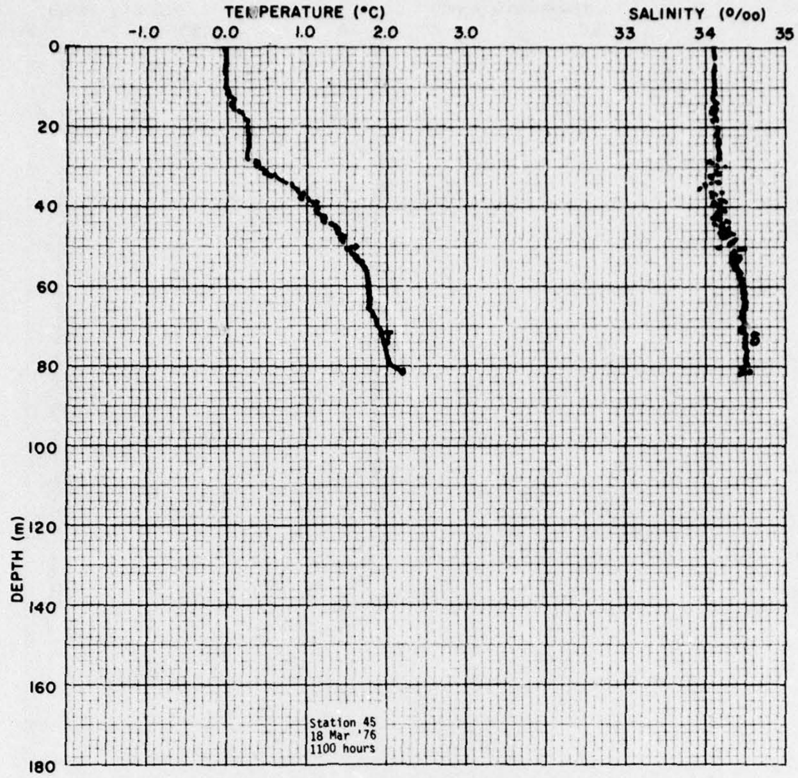
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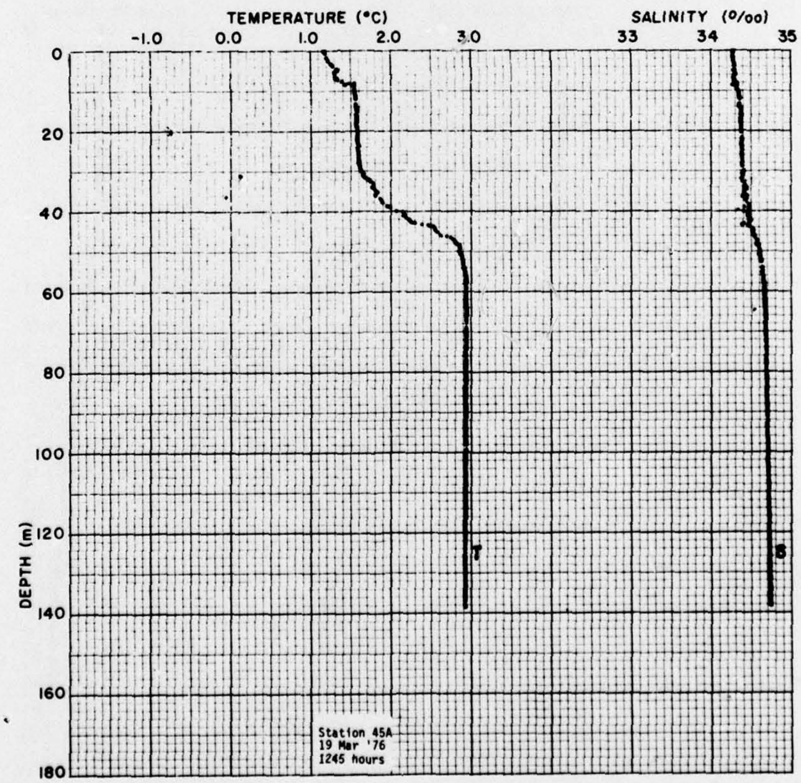
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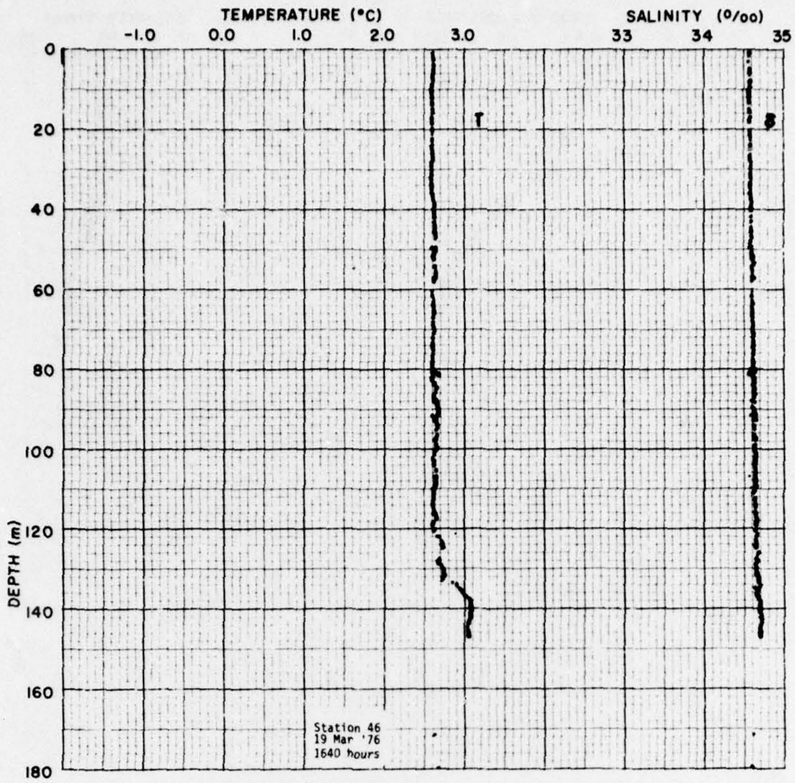
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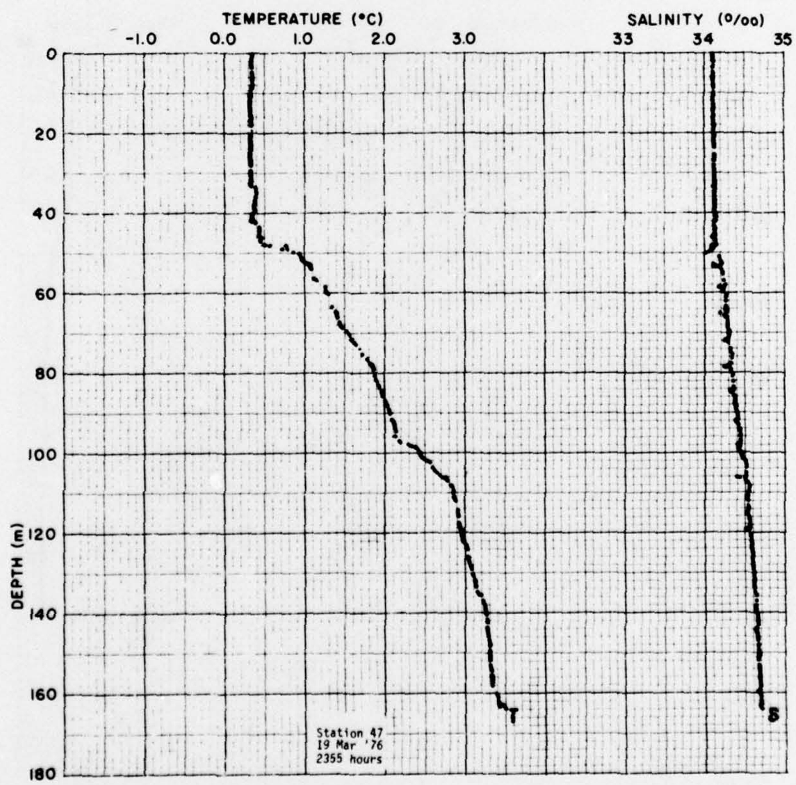
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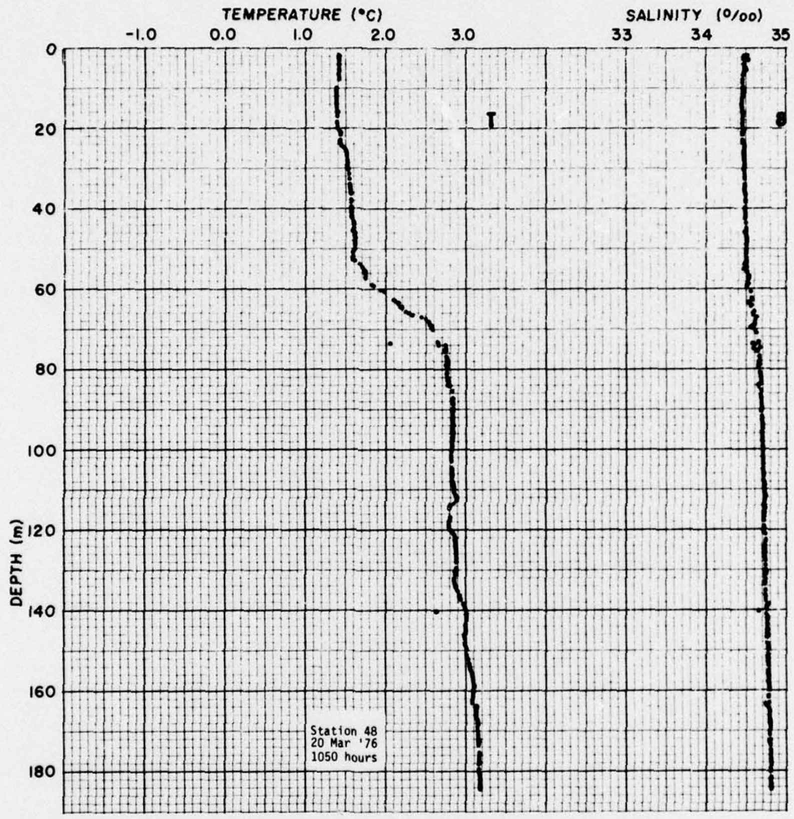
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20 Mar '76
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Baffin Bay Oceanographic Measurements
Barrow Canyon Oceanography
Alaskan Coastal Current

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An oceanographic survey was conducted by helicopter in April 1976 in the ice-covered Chukchi Sea. This survey verified the existence of the bottom layer found a year earlier that had a temperature near the freezing point and a salinity relatively high for the Chukchi Sea. This bottom layer flows along Alaska's northwest coast, through the Barrow Canyon, and into the Arctic Ocean. Its path is clearly visible in the

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vertical profiles of temperature and salinity taken at several lines of stations across the coastal zone. The flow down the Barrow Canyon is opposed by a westward spreading of the temperature-maximum layer of the western Arctic Basin and by an apparent uprising, or surge, of warm, saline Atlantic water from its usual depth of 140 m in the Arctic Ocean to a depth of 75 m. Similar conditions were observed in the spring of 1975.

Some oceanographic measurements from an icebreaker were also conducted in Davis Strait and Baffin Bay during late February and March 1976. Temperature and salinity profiles revealed a deep, warm layer in Davis Strait which extended northward, with diminishing temperature, into Baffin Bay.